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(PAGE 68)

SEPTEMBER 2004

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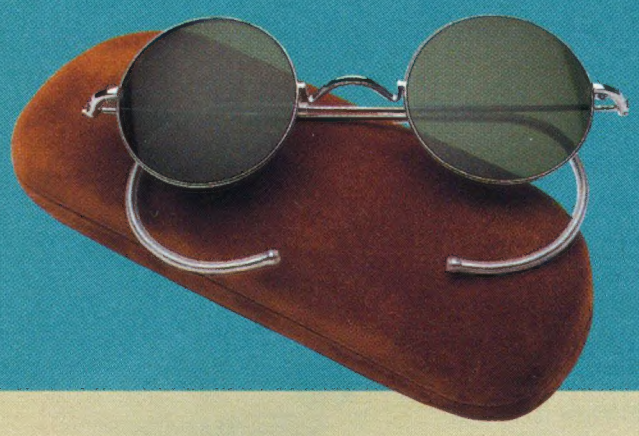

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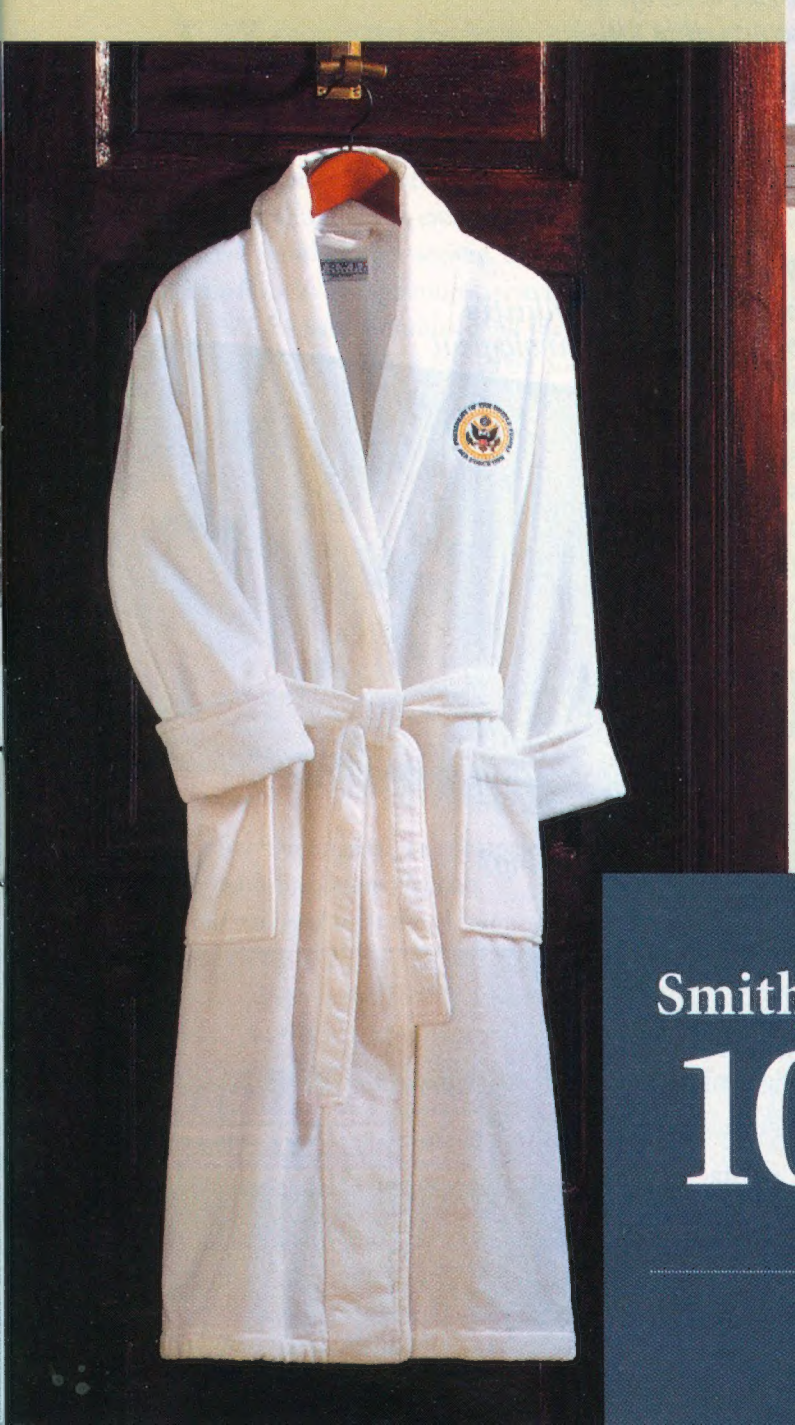

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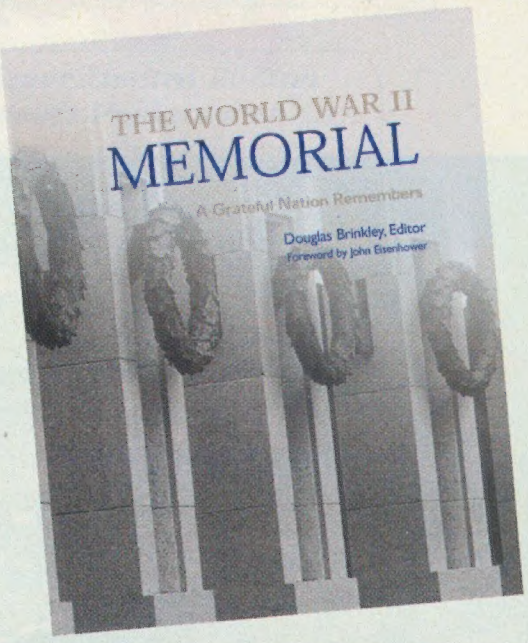

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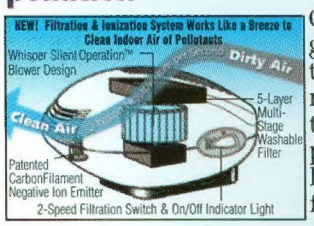
Caution: the air you breathe could be hazardous to your health

The Environmental Protection Agency estimates that indoor air at home and at work may be up to 10X more polluted than the air outside! Often it is odorless, lurking like an invisible monster that causes eye, nose, or throat irritation, headaches, dizziness, fatigue, and increased asthma attacks.

Clean air better with BOTH filtration & ions

An ionizer without filtration can only control a percentage of pollution. The Bell+Howell® Air Purifier and Ionizer cleans air better as it passes ionized air through a 5-layer multi stage cassette filter.

Two trillion ions per second bombard pollution



Our patented carbon-ion generator is silent and exceptionally powerful. Streams of negative ions rush like an army to bring down the invading pollutants and odors. Air is left with the crisp, rejuvenating feeling of a spring day!

Whisper Silent Operation™

The Bell+Howell® Air Purifier and Ionizer has a Whisper Silent Operation™ so you won't even know it's on! Its 2 speed operation allows you to switch to clean air at ultra speed or Whisper Silent Operation™ use for 24/7 cleaning.

Never buy replacement filters again

The Bell+Howell® Air Purifier and Ionizer uses a permanent filter, which is easy to clean and never has to be replaced. Air cleaners that don't use filters can create their own pollution. Interior parts that collect the dust have to be removed and scrubbed, and some of that gunk winds up on your walls and furniture!

Costs just pennies a day to run

The Bell+Howell® Air Purifier and Ionizer uses only 14-24 watts, less electricity than a 60-watt bulb! So why pay hundreds of dollars for an ionizer when you can get a combination ionizer & filtration air cleaner for so much less?

Tested & proven to work

The Bell+Howell® Air Purifier and Ionizer has been tested and given a CADR (Clean Air Delivery Rate) from a leading testing laboratory in accordance with the Association of Home Appliance Manufacturers (AHAM). Many Ionizers you've seen can't make that claim.

How can we offer this quality at such a price?

This air purifier and ionizer features the expertise and quality that you would expect from Bell & Howell®, a leader in cutting edge products for almost 100 years. Due to volume capabilities, we have an exclusive arrangement to offer it to you at an unbelievable price. But at this price, stock will be going out fast! Ask for pricing when you buy 2 - you can get one for every room!

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AUGUST/SEPTEMBER 2004 VOL. 19 NO. 3

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FEATURES

Cover: *Against the Tehachapi range in California, Robert Scherer's Starship NC-51 glistens in alien splendor. Chad Slattery shot it from a camera plane flown by Chuck Coleman.*

DEPARTMENTS

War Between Financiers Creates First $11,000,000 Watch

Henry Graves and James Packard were two of the richest and most competitive men in the world in the 1920's and 1930's. Graves made millions in banking and railroads while Packard was crafting some of the most beautiful automobiles ever built. But in their genteel world of high society, they were at war. Their favorite competition…watch collecting. In 1927 Packard commissioned the world's most complicated watch but not to be outdone, Henry Graves surpassed his rival in 1933 with a single masterpiece. It took over 3 years to engineer this chronograph and only one original watch was ever built. It was held in the Museum of Time for years until it was recently auctioned off for the record price of over $11 million dollars at Sotheby's.

Our vintage watch craftsmen were fascinated and inspired by this rarest of all watches and they have given a new life to this 1933 masterpiece by creating our Graves™ watch.

Just like the original, the enameled face with handsome Roman Numerals highlight the classic antique design. The case and screw down crown are in 5 mil 24-karat gold. But the real beauty of this watch is on the inside. We replicated an extremely complicated early automatic movement with 27 jewels and seven hands. There are over 210 individual parts that are assembled entirely by hand and then tested for over 15 days on Swiss calibrators to insure accuracy. The watches are then inspected again in the United States upon their arrival.

27 jewels and 210 hand-assembled parts drive this classic masterpiece

What makes rare watches rare?

Business Week states it best, "It's the complications that can have the biggest impact on price." (Business Week July, 2003) The hands of the four interior complications on our Graves™ watch display the month, day, date, and a 24 hour clock that graphically depicts the sun and the moon. The engine for this timepiece is powered by the movement of the body as the automatic rotor winds the mainspring. It never needs batteries and never needs to be manually wound. The precision crafted gears are "lubricated" by 27 rubies that give the hands a sweeping movement. And the watch is tough enough to stay water resistant to 5 atmospheres.

Not only have we emulated a stunning watch of the 1930's but just as surprising, we've been able to replicate the prices of the 1930's.

The fine 27-jewel automatics that are on the market today are often priced well over $2000 dollars but you can enter the rarified world of fine watch collecting for under $200. You can now wear a millionaire's watch but still keep your millions in your vest pocket. Wear this vintage the handsome Graves™ timepiece risk free for 30 days. If you are not thrilled with the quality and design, please send it back for a full refund of the purchase price.

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Save Our Suits

In 2001, the National Air and Space Museum's space history division began an undertaking to save threatened artifacts from the Apollo space program, with a focus on spacesuits developed for the moon landings of the late 1960s and early 1970s. The Save America's Treasures grant program, a public-private partnership between the White House Millennium Council and the National Trust for Historic Preservation, with a generous donation from Hamilton Sundstrand, a United Technologies Company, provided funding.

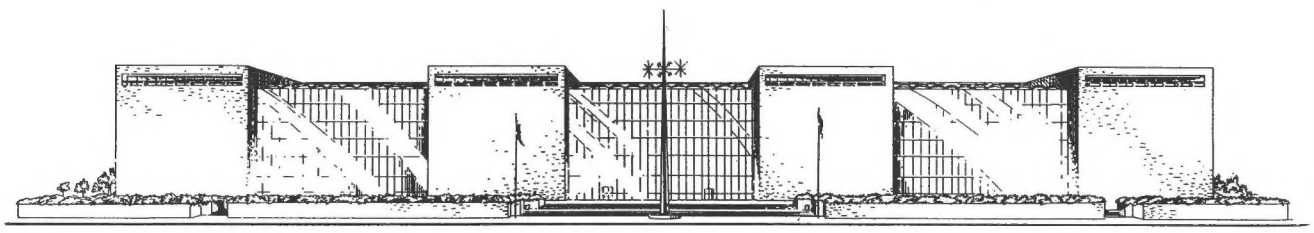
Our primary goals are to preserve the spacesuits in the Museum's collection and to share with others what we learn about the aging and preservation of spacesuit materials. Spacesuits contain metal parts that are durable, but other parts—including fiberglass and Teflon fabrics, plastic, and rubber—deteriorate over time. Members of the space history staff examine and document every spacesuit and perform non-destructive analysis, meaning we examine the suit without damaging it, identify and photograph areas of damage, and document its history to describe the present condition of the suit and permit us to monitor changes. Depending on the condition of the materials within each suit and the suit's intended disposition (storage, exhibition, or research), we treat corroded areas and take measures to conserve the suits.

We photograph and clean each suit and its components, and then construct and insert a storage or display mannequin. Finally, we fit cradles, trays, or containers for each spacesuit component (helmet, boots, or gloves). We evaluate the data collected during this phase of the project and compare it with existing information on the history, technology, and preservation of spacesuits. We consolidate all that information and update computer records that will be made available for study on the Smithsonian Institution Web site.

The project staff established an advisory group consisting of materials experts and scientists, all of whom have generously donated their time and knowledge to research the deterioration and preservation of these suits. Because of the scarcity of reliable published information, substantial research and extensive consultation with industry experts and conservation professionals was necessary. One result of this effort is that the Museum will serve as a national clearinghouse for information pertaining to spacesuit preservation and conservation. The information will enable us to better understand the degradation of the materials when the spacesuits are displayed.

The project also led to guidelines and standards of practice for the conservation, storage, and display of spacesuits; these have been published and serve as a blueprint for further research while offering advice on the management of spacesuits and other pressure suits. The guidelines have been disseminated to various organizations responsible for the preservation of spacesuits and to those who either have borrowed or wish to borrow a spacesuit from us for display.

—J.R. Dailey is the director of the National Air and Space Museum.



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LETTERS

Tales From Scooterville

During my career in the F-16, I had the pleasure of fighting with and against the A-4 ("The Hotrod Squad," June/July 2004). In a Cope Thunder exercise near Clark air base in the Philippines, they were on time, on target as part of my 60-ship attack. And in air combat maneuvers over the White Mountains of New Hampshire, they proved excellent adversaries.

Some observations: The A-4 had no afterburner, and to sustain 6 Gs in a turn at 15,000 feet is quite a task. A lightly loaded F-16 could sustain 8 to 9 Gs at 15,000 feet but in full afterburner. Also, the A-4 is very small and hard to see, and the old adage "Lose sight, lose fight" applied: If you didn't keep the little jet in sight, you'd become a movie star in the A-4's gun camera film.

With the advent of beyond-visual-range missiles, AWACS (the airborne warning and control system), and other technologies, some question the relevance of close-in air combat. Will fighters ever come to a "merge" again if they are identified from far away and can be targeted and killed without being seen?

In any case, I'm glad to see that there is still a lot of fight left in the Scooter.

Lt. Col. Larry "Oz" Owsowitz
U.S. Air Force Reserve (ret.)
Concord, New Hampshire

Graham Chandler describes a legitimate company providing a service to the pilots of our armed services that will better prepare them to survive air combat. Why then, with so many U.S. A-4s retired at Davis-Monthan Air Force Base, is ATSI required to purchase its aircraft from foreign governments? Something is very wrong here.

Louis Peters
Montara, California

Graham Chandler replies: I asked that question of Jon McBride, the chief operating officer of ATSI, and he replied: "We tried to secure airplanes from the [U.S.] service, but it got down to the last decision-maker and he said, 'If I do this for you, I'll have to do it for anyone who walks in the door." It seems the U.S. government balks at selling still-potent warplanes to civilian firms.

When I worked at Douglas Aircraft (from 1978 into 1981), some of my co-workers worked on the A-4, and they told me that during the Skyhawk's design, Ed Heinemann spied a plastic defroster duct on an engineer's table. He grabbed it, dropped it on the floor, and stomped on it. "There'll be no &%#*@ plastic parts in my airplane!" he declared, leaving the room. From then on, that process was known as the Heinemann Stress Test.

Tom Ross
Colorado Springs, Colorado

Thanks for Your .0165097 Euro's Worth

The article on the B-1's latest records ("B-1 Shoots, Scores," Moments & Milestones, Apr./May 2004) was all but unreadable due to the overuse of metric weights and measures. I'm surprised you didn't give pressures in millibars or fuel capacity in liters. The use of both metric and non-metric was also confusing. In one short article, you used kilograms, kilometers, pounds, feet, and miles.

The standard measurements in aviation are still feet, pounds, nautical miles, and inches of mercury. It's not going to change soon—and your articles should reflect that.

Scott A. Dommin
Bedford, New Hampshire

Editors' reply: U.S. aviation record-setting is overseen by the National Aeronautic Association, and that organization categorizes some records metrically (15- to 25-kilometer straight course, 150,000- to 200,000-kilogram weight class, etc). We add non-metric equivalents and, on occasion, conversion formulas as a convenience to readers.

On the QT

In 1968, I was stationed in Soc Trang with "the Shotguns," the 221st Reconnaissance Airplane Company, flying Bird Dogs (Army L-19s/Air Force O-1s). I was there when the QT-2 flapped on and off the runway, much to our amusement ("Night Stalkers," Apr./May 2004). I remember getting ready to fly a night recon mission when I was startled to see a landing QT, or "cutie," putter past our hangar next to the runway. I hadn't heard it land. The warning everyone got was to be extra careful around the flightline because you could never hear the dang things coming—sort of like butterflies. After landing, they were parked in a hangar behind big trailers that were pulled into position to hide them.

Rich Stanko
Omaha, Nebraska

Clean your air silently for *HALF* the price!

Tests show the powerful Silent Surround Air Ionizer cleans your air with more Ionic power for half the price!

According to the Environmental Protection Agency, the air inside your home can be up to 10 times more polluted than the air outside. Most of our homes and offices are now sealed from fresh air so indoor pollutants are kept in while natural air cleansing agents are kept out. The EPA informs us that 6 out of 10 homes and buildings are "sick", meaning they are hazardous to your health as a result of airborne pollutants. Health problems relating to this phenomenon are real—Asthma cases have increased by more than 100% since 1976. It's time to put an end to your own personal air pollution problem.

"It's so quiet I kept checking to be sure it was on. However, as the afternoon wore on, I knew for CERTAIN that it was on because in ONE AFTERNOON, my sneezing and running eyes have stopped! I vacuum daily because I am so allergic to dust. However, all the vacuuming in the world has not produced the results that one afternoon of Surround Air has."

—J. McNally, Mass.

How to Clean the Air inside of Your Home

Our goal was to find the most scientifically advanced air cleaning technology and build it for an affordable price. Well, we believe that we have succeeded beyond our wildest dreams. In a 16' x10' room, the breakthrough Surround Air was able to remove 99.2% of all particles that were .3 microns or larger. This allowed us to capture most pollen, cat dander, molds, fungus, dustmites and allergens that can lead to significant health problems.This test showed far better air cleaning results for the Surround Air, than for the other popular ionic cleaner on the market...***which costs twice as much!***

How were we able to achieve such great results? We used 16 stainless steel ion producing needle-points to create a much larger negative ion count. Plus we were able to create the "silent fan" technology that circulates more air through the cleaning grid while operating in complete silence—you can even run the Surround Air while you sleep. We were able to do all of this while using 40% less electricity thus reducing your operating costs.

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LETTERS

I worked in the engineering department of the Cessna Aircraft Company in Wichita, Kansas, from 1965 to 1972. Near the end of that time, the U.S. Air Force sent a YO-3 to Cessna for our department to evaluate. I was surprised at how noisy it was. It quickly became evident that all the unwanted sound was coming from the stainless steel exhaust pipe running from the engine compartment, under the aircraft belly, to a large muffler mounted in the tailcone. The exhaust pipe was resonating with the engine pulses, transferring each *ping* of the exhaust valve opening. That was a good lesson for me: Unless *all* noise sources are addressed, you will still have a noisy piece of equipment.

Raymond Winn
Stansbury Park, Utah

There is one more YO-3A out there: It has been sitting (and rotting) on the ramp at Skagit Regional Airport in Mt. Vernon, Washington, since 1986. Nothing has been done to protect or restore it, and it sustained damage when another plane taxied into it one night in the late 1980s.

One nit: In the Apr./May issue (On the Web Site), you incorrectly captioned a picture as showing a YO-3A. It shows the QT-2.

Tom Staggs
Redmond, Washington

Editors' reply: We've made sure the information about the YO-3A in Washington gets to the Quiet Aircraft Association, an organization that sprang up as a result of our story.

The Amen Corner

As an early convert to and longtime user of George Braly and Tim Roehl's engine leaning methods and their balanced fuel injectors ("First Church of Combustion," June/July 2004), I was sorry that little mention was made of their most dramatic development, which awaits certification by the Federal Aviation Administration: a computer-controlled, variable-spark-advance, electronic spark ignition system, with spark timing based on intra-cylinder pressure monitors. Like the cars we drive, it will require no attention from the operator. This system would move the operation of aircraft piston engines into the 21st century, while allowing the safe use of aviation fuels that are not 100 octane and do not contain tetraethyl lead.

Bill Pappy
Southlake, Texas

Though I hadn't heard of Braly and Roehl, I have long been preaching the gospel. In the 1960s, while flying the C-141, I met and became fast friends and fishing buddies with a former B-36 flight engineer named Ernie. Ernie told me that the endurance of that airplane was greatly extended by leaning the engines "beyond the point of detonation." This was done by using extensive engine instrumentation—oscilloscope analysis, possibly of each cylinder. Many years later, after I'd acquired a Cessna 180, I met an oldtimer who advised a much more aggressive leaning regime than conventional wisdom dictated. These two sources, coupled with reports of valve problems in the type of engine in my airplane, convinced me. I began leaning my engine a lot more—even on the ground, and whenever my EGT and CHT (exhaust-gas and cylinder-head temperature gauges) said I could. Soon I saw results: Fuel consumption went down, compression values went up, and cruising speeds increased.

Lt. Col. Alden C. Belcher
U.S. Air Force (ret.)
Calais, Vermont

No Way to Treat a Comet

"Celestial Body" (Restoration, Dec. 2003/Jan. 2004) mentions that the Comet now owned by Seattle's Museum of Flight had been abandoned at Seattle's Paine Field in 1979. I have more information on that.

It was just a day or so before the now-defunct Washington State Air Fair airshow that the aircraft flew in. The Comet's crew came off the airstair at full gallop and quickly disappeared. During the airshow, the plane gathered lots of attention, and lots of photos were taken. Sunday afternoon: departure time and no Comet crew. Monday: no crew. After several days, the aircraft was towed to the south end of the field and parked.

The field had no luck finding someone to take responsibility for the plane, so it finally seized the Comet for nonpayment of tiedown fees and donated it to one of the field's tenants—Everett Community College's aircraft mechanics' program—for use as a teaching aid. Taking pity (and probably seeing a PR opportunity), local company Boeing got in on the act, repainting the airframe in Comet-era BOAC colors and getting the Comet registered as G-EVCC (for "Everett Community College"). The school quickly found that students learned little from the Comet, so it just parked the aircraft out front as a landmark.

William R. Downing Jr.
Everett, Washington

Flying Art

If Brancusi or Jean Arp had created a shape like the P-38 ("*Glacier Girl*," Feb./Mar. 2004), it would have been considered a beautiful sculpture. Should *Glacier Girl* be in an air museum, or an art museum?

—Hilliard Stone
Irving, Texas

Corrections

June/July 2004 "The 30 Billion Dollar Man": The photograph on page 37 shows Seddik Belyamani in Equatorial Guinea, not Cameroon.

"Old Bombers, New Tricks" (Soundings): The photograph shows a B-57B, not, as implied, a WB-57.

"...And There's Room for 15 More Inside!" (Soundings): The Dornier Do-X had 12 engines, not 10.

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e-mail: editors@airspacemag.si.edu. *You must include your full name, mailing address, and daytime phone number.*

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All letters selected for publication are edited. We regret that we cannot respond to every letter.

Top: SpaceShipOne *and* White Knight *ascend; above: brand-new astronaut Michael Melvill bear-hugs hardware guy Burt Rutan while money guy Paul Allen grins.*

The Lotus 7 of Spacecraft

Some years ago Burt Rutan stood before a crowd in a tent at the Experimental Aircraft Association fly-in at Oshkosh, Wisconsin, and asserted that "the jump from Pietenpols and Stitses to a pressurized Lancair is bigger than the jump from the Lancair to an airplane that can go into space." The technology available to homebuilders, he went on, was already so advanced that you could create an extra-atmospheric homebuilt out of parts and materials from the catalogs of airplane parts supplier Aircraft Spruce and industrial equipment giant McMaster-Carr.

Ten years and more than $20 million of Microsoft tycoon Paul Allen's money later, he admits that he was wrong. It was a much bigger jump than he thought.

His initial version—what Rutan now calls the 1999 design—was smaller and less powerful than *SpaceShipOne* and could have been carried aloft by Proteus, Rutan's tandem-wing twin-jet that first flew in 1998 and has had a busy career as a for-hire high-altitude research platform ever since. He discarded that design, along with a number of alternative reentry configurations, when digital simulations, using computational fluid dynamics software, showed that they lacked the desired stability characteristics for both subsonic and supersonic flight.

SpaceShipOne is essentially a tiny airtight cabin glued—literally—to the front end of a rocket motor. It's the Lotus 7 of spacecraft, tight and light, utterly fat-free. But many designers could have built something small and light and attached it to a powerful motor. Rutan's genius seems to reside in his ability to combine several seemingly unrelated innovations into a seamless whole, and *SpaceShipOne* embodies that ability.

The most fundamental advance is the hinged or "feathering" wing. Rutan once said that his creativity resided in feeling at home "amid chaos and nonsense." He can't or won't pin down the source of this bizarre inspiration, but it looks a little like a tilt-wing airplane he once built, and a little like a free-flight model in "de-thermalizer" mode (Rutan was a competition aero modeler as a teenager). With the airplane folded like a beach chair along the middle of its wing, it descends at an angle of about 60 degrees while presenting a large, flat, enormously draggy surface to the wind.

BRAINTEASER

Do the Math

The recent annual Airline Quality Rating study, which ranks the 14 largest U.S. airlines on on-time arrivals, denied boardings, mishandled baggage, and customer complaints, put Jet Blue at the head of the class, followed by Alaska Airlines, Southwest, America West, and US Airways. Co-researchers at the University of Nebraska at Omaha and Wichita State University included in a press release the formula they used (warning: may trigger hives in mathophobes).

$$AQR = \frac{(+8.63 \times OT) + (-8.03 \times DB) + (-7.92 \times MB) + (-7.17 \times CC)}{(8.63 + 8.03 + 7.92 + 7.17)}$$

OT = On Time **DB** = Denied Boardings **MB** = Mishandled Baggage **CC** = Customer Complaints

Miraculously, the natural trim of the configuration is almost the same at both supersonic and subsonic speeds, so no sharp adjustment occurs as the craft decelerates through Mach 1. The feathered configuration has rock-solid stability at supersonic speed; only during its brief periods of subsonic flight does it shake and wobble as the stalled wing sheds vortices in its wake.

The test program had uncovered its share of problems, all subsequently diagnosed and fixed. But one system that has reliably performed beyond expectations is the feather and, in tandem, the insulating material that helps defend the composite structure against the 1,100-degree temperatures of reentry. Rutan lowers his voice conspiratorially to disclose that "it's made of the eyelashes of Nicaraguan racing spiders."

The key to safe reentry is the key to routine spaceflight, and Rutan thinks he now holds it. Two hours after *SpaceShipOne*'s 62-mile-high flight of June 21, he was telling the press about large-window suborbital tour buses that would climb to 100 miles to give six to 10 paying passengers a longer look at space as well as time to float around the cabin. And later, "transfer vans" would loft vacationers to orbiting hotels. Rutan felt sure he already knew how to air-launch a 600,000-pound spacecraft. Now that private enterprise was competing with NASA—which he pronounces "nay-say"—it was just a matter of time. And whenever newer, larger, and more powerful versions were built, the revolutionary technology of feathered reentry would be part of them.

—Peter Garrison

TYSON V. RININGER (2)

HEADS UP

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For the past few years, Microsoft co-founder Paul Allen has been acquiring World War I and II aircraft from around the world and having them meticulously restored to flying condition. Last April, Allen flung open the doors of the unassuming hangar at Arlington Airport and welcomed the public—though only to groups of 15 at a time so that visitors have plenty of elbow room. Currently a dozen World War II aircraft are displayed, along with a Curtiss JN-4D Jenny, with another 12 still undergoing restoration. A behind-the-scenes look at the Allen collection will appear in an uncoming issue of *Air & Space/Smithsonian.*

JOHN M. DIBBS/PLANE PICTURE COMPANY INC.

One of the Flying Heritage Collection's most prized artifacts, a Supermarine Spitfire Mk.Vc, will fly for visitors some four times a year, along with half a dozen other airworthy World War II aircraft and a Curtiss Jenny.

The Truth Is Out There

One less alien craft is sailing the high seas of space. Image analysts at NASA have debunked a theory that the crew of Apollo 16 captured a UFO on 16-millimeter film in April 1972. No one is certain which of the astronauts—John Young, Thomas Mattingly, or Charles Duke—shot the four seconds of footage. In about 50 frames, a saucer-shaped object with a dome on top appears in a window of the command/service module. The object appears momentarily near the moon, and moves in and out of the field of view as the camera pans back and forth.

The encounter was similar to many that astronauts are alleged to have had, from the Mercury program to the International Space Station. When a blob of liquid floating in front of a space shuttle window shows up on television, it can look quite mysterious—and inquiring minds want to know. "This is the third one our office has analyzed, and all of them turned out to be nothing other than grape juice, chunks of ice, or hardware," says Gregory Byrne, leader of the Image Science and Analysis Group at NASA's Johnson Space Center in Houston. In the case of Apollo 16, the unidentified flying object is now identified as a floodlight the astronauts used to illuminate their spacewalk. The light was attached to the command module by a boom that got lost in shadows.

Byrne hadn't even heard of the sighting until a letter from U.S. Congressman Dutch Ruppersberger of Maryland and a fuzzy copy of the video landed on his desk late last year. "I did a Google search on 'Apollo 16 UFO' and discovered it had been out there a long time," he says. NASA normally doesn't waste its resources on flying saucer sightings, but this inquiry came from Congress.

The image analysis group set aside their work in helping NASA recover from the shuttle *Columbia* disaster, and Byrne and five others became UFO investigators. They pulled the actual film out of cold storage and looked at it with a magnifying lens on a light table. The truth was apparent, and to make sure, they scanned the film digitally at high resolution and computer-enhanced the results to bring out low-light details. They also searched NASA's archives for similar images from other missions and found several.

"[It] was about the last thing we needed to go off and spend time on, but as it turned out, it was a very interesting diversion," says Byrne, who likened the project to a trip back in time. "My father worked on Apollo, so for me, this was like stepping into his shoes."

—Beth Dickey

Midway Settles In

The aircraft carrier *Midway*, CVA-41, has launched on its last mission—as a floating museum in downtown San Diego. Named for the South Pacific island and battle so pivotal in World War II, it attracted hundreds of former crewmen from nearly five decades of service to the June 7 opening, entitled Midway Magic.

"The crew was really the magic," says Rear Admiral Riley Mixon, a *Midway* commanding officer in the mid-1980s and now acting chairman of the Midway Museum Board. While other Navy vessels had a theme song for morale, "it was usually 'rah, rah' stuff. Our crew's music was Crystal Gale's 'We Must Believe in Magic.' "

Ken Winter was an 18-year-old signalman on *Midway*'s shakedown cruise in September 1945. "I grew up in a small Illinois town, so was awestruck at the size of her," he says. Winter has that year's Thanksgiving menu, which included "Roast Young Tom Turkey, Giblet Gravy, Baked Spiced Ham, Buttered Peas, Candied Sweet Potatoes, Hot Mince Pie," and the post-prandial "Cigars, Cigarettes."

Midway, for 10 years the world's largest warship, steamed first to Guantanamo, Cuba, then north to the Arctic Circle in Operation Frostbite, the Navy's first test of a ship, aircraft, and crew in extreme temperatures. "I've never been so cold in my life," recalls Sam Amato. Now 77, he traveled from Niagara Falls for the gala opening.

The Navy's longest-serving carrier, *Midway* was also the flagship in the Persian Gulf for Desert Storm in 1991, 46 years after Amato's and Winter's cruise. Its aircraft were the first over Iraq, where it was the only carrier to lose no aircraft.

ARLO K. ABRAHAMSON/US NAVY

Midway *maneuvered into its final home as a floating museum on the San Diego waterfront after a stopover at Naval Air Station North Island.*

Other carrier firsts accomplished on *Midway* include the launch of a rocket (a captured German V-2) in 1947 and the first takeoff by a jet-powered aircraft (a Ryan FR-1 Fireball, while steaming up the Hudson River) in 1946.

While nostalgia was the pervading sentiment for many, hundreds of younger visitors questioned docents, took the audio tour, and admired the airplanes on the four-acre flight deck, including a McDonnell Douglas F-4 Phantom II, an LTV A-7 Corsair II, and a Grumman E-2 Hawkeye. As the San Diego Aircraft Carrier Museum, *Midway* will serve as an interactive educational and event venue, including a Boy Scout campout site. The Navy's newest carrier, the USS *Ronald Reagan*, CVN-76, was due to arrive July 23, a few hundred yards across San Diego Bay.

—Bob McCafferty

UPDATE

"CVR" Returns to Off-Broadway

The sleeper hit play *Charlie Victor Romeo*, which reenacts the harrowing transcripts from the cockpit voice recorders of several airliner accidents, returned to Off-Broadway late last May ("Now Playing: The Way Things Go Wrong," Soundings, Feb./Mar. 2000). *Playbill* notes: "Audiences typically emerged from the show shaken and silent." The producers estimate that one third of the play's audiences have been part of the aviation community.

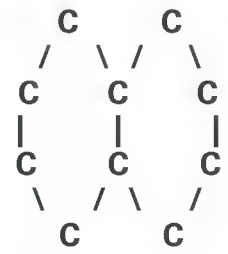
Cool Fuel

Researchers at Pennsylvania State University have developed a jet fuel derived from coal that has unusually high resistance to heat-induced breakdown. Dubbed JP-900 (the number refers to its maximum temperature tolerance in degrees Fahrenheit), the fuel addresses an Air Force need for fuels that can help cool today's engines without degrading in the process. The concept of using fuel as a heat absorber was a crucial element in the design of the SR-71 Blackbird.

According to Harold Schobert, director of Penn State's Energy Institute, the notable difference between the new fuel and a traditional jet fuel such as JP-8 is that JP-8 has more straight- and branched-chain hydrocarbon molecules called alkanes, which look like this:

C-C-C-C-C-C...

whereas JP-900 has more cyclic molecules that look like pairs of rings:



The strong bonds between carbon atoms in ring-shaped hydrocarbons give them their resistance to heat and enabled JP-900 to capture the attention of the U.S. Air Force Office of Scientific Research, which has supported the Penn State project for about five years.

Schobert says it all started when a story circulated about a Soviet pilot who defected in the 1980s and landed at a point beyond the known range of his aircraft. At the time, scuttlebutt said the CIA examined the jet and found a surprising amount of fuel in the tanks—a type that had more heat energy per unit of volume, or energy density, than kerosene, which explained how the craft flew so far. Schobert thought similar fuels could be developed from coal and wrote a paper to that effect in the late 1980s. Experiments with coal tar—the thick liquid ooze found in Canada and the northern states—were just winding down at the time, and Schobert credits U.S. Congressman John Murtha of Pennsylvania with timely support for Penn State's research. Initial funding came from unused money from the coal tar project.

The two leading processes for making the fuel piggyback off existing oil refinery and coke production methods, reducing the investment requirement to some grinding and blending equipment obtainable at modest cost. In addition to its attractive high-temperature characteristics, the new fuel offers the U.S. military a strategic leg up by assuring a domestic source of jet fuel based on plentiful coal supplies. Reserves of coal are estimated by the Department of Energy to be sufficient for U.S. energy needs for 250 years; reserves of oil shale—stone impregnated with hydrocarbons that can be heated, extracted, and refined—are reportedly even greater.

—George C. Larson

Supersize It

Oregon's Evergreen International Aviation, a longtime player in the airborne firefighting business, conducted test flights last March for a potential addition to the fleet of air tankers. After responding to a Department of the Interior call for ideas on a next-generation tanker, the company retrofitted one of its Boeing 747 jetliners with a 24,000-gallon tank system designed to drop water, fire retardant, or oil dispersants. Boeing is working with Evergreen to get Federal Aviation Administration certification, which both companies expect by September.

"Four large tanks were installed in the huge main deck of the 747-200F," says Evergreen spokesman Justin Marchand. "Large air tanks pressurize the system and regulate the flow of the firefighting material. Large pipes were run through the floor into the aft cargo compartment."

The Supertanker's capacity is roughly six times that of current heavy air tankers—ex-Navy P-3s and P2Vs and DC-4 through -7 airliners (which have been grounded until maintenance standards can be set and will likely not fight fires this season)—and more than three times that of the mammoth Martin Mars flying boats used to fight Canadian fires. Evergreen says benefits include a constant-flow dispersal system, overwhelming volume for initial-attack fire suppression, faster flight speed for improved fire response time, and much longer retardant line length.

EVERGREEN

Forecast: Brief but heavy and localized showers as Evergreen's 747 firefighter tanker tests its drop capacity.

Pilots are undergoing a training regimen designed to familiarize them with the jetliner's new flight profile. Current parameters call for a minimum drop altitude of 800 feet.

"Boeing did a great job designing this aircraft; it's a joy to fly," says air tanker pilot Bob Hennigan, formerly a 747 copilot. "But it's still a transport aircraft, so this seems a bit like teaching an elephant to dance. It's going to require a very large area to turn."

"The real question is how effective the Supertanker will be in the high winds and turbulence at the height of an urban-interface [city-edge] forest fire," says Associated Airtanker Pilots' safety chairman, Walt Darran.

In air tanker pilot Dean Talley's view, runway requirements are challenges. "There are few airports in the present system capable of supporting sustained operations using jumbo jets, given the logistical challenge of supporting so large an airframe with fuel, retardant, and maintenance," he says. Evergreen says it is refining agreements with military bases for support.

DC-10s have also been considered for firefighting, and Boeing's Integrated Defense Systems group is looking at using the C-17 transport as a water bomber. Instead of spraying liquid from tanks, the C-17 would employ the Precision Aerial Fire Fighting system, which consists of up to 2,800 biodegradable water-filled spheres stacked on pallets in cardboard containers. An aircraft would release groups of the spheres to smother an emerging wildfire. However, at 50 pounds each, the firefighting beach balls pose a danger to firefighters on the ground.

—Paul M. Ross Jr.

AIR RACING NEWS

Everything About It Is Fast

Jon Sharp's Formula One air racer, *Nemesis*, won 47 consecutive races, set 16 speed records, and retired to the National Air and Space Museum. Never one to rest on such laurels, Sharp designed and built Nemesis 2.0, or in Sharp's lingo, *NemesisNXT*, short for Neoteric Experimental Technology, for Sport Class racing.

The original *Nemesis* was built solely for racing, but Sharp says the two-seat, all-composite, turbocharged NXT is more well-rounded. "It's about a 60 percent A-to-B airplane, Los Angeles to Oshkosh, and 40 percent race plane," he says. NXT will make its general debut at the Experimental Aircraft Association's AirVenture in Oshkosh, Wisconsin, and its working debut at the Reno Air Races in Nevada in September. Because the Sport Class consists of kit aircraft, Sharp and his team had to produce five kit packages, which are now available for $129,500 each. Team Sharp says kit assembly is "breathtakingly fast."

—Wayne Sagar

He Loved Rockets

When science teacher Herbert Desind died of cancer in 1992 at the age of 47, he left behind a large legacy—109 cubic feet of space-related photographs, to be exact.

Desind's passion for rockets and space exploration had driven him to collect more than 100,000 photographs, which he acquired from military, government, and corporate sources. In 1997, his sister donated the collection to the National Air and Space Museum, where the materials are now available to researchers.

Museum archivist Brian Nicklas, who has spent one day a week for the past three years organizing the photographs, first saw the collection in Desind's house in Silver Spring, Maryland, where he had stored the documents in file cabinets "packed to the point of exploding." Most of the items were organized in folders once used for Desind's science classes.

Apparently Desind never saw a space image he didn't want. "It seems like he wasn't real picky—he just wanted it," says Nicklas, pointing out that though some of the photographs are great shots of a specific aircraft, they are often lumped together with missiles under Desind's filing system. "Some people would say, 'That's a great picture of an F-5,' " says Nicklas. "I'm sure Herb could [not] have cared less about the F-5. He just wanted the Bullpup [air-to-ground missile]."

Thomas Soapes, chairman of the archives division, says the materials are welcome additions to the Museum's archives. "The collection did fill in a lot of holes in our space history collection," he says. Although some of the photographs duplicate those already in the Museum collection (Desind often turned to the Museum as a resource),

When he wasn't launching rockets, Herbert Desind was collecting photographs of them, including an image of four MX missile warheads re-entering the atmosphere (background).

Desind fancied the Shrike missiles carried by two U.S. Navy Vought A-7Es flying over Spain.

DANE PENLAND

Almost toy-like in its proportions, the Bede BD-5 aerobatic kitplane is just over four feet tall and 13 feet, four inches long. Designed by James R. Bede (pronounced "BEE-dee") in the late 1960s, the BD-5 was advertised as an affordable airplane that required no more than 400 hours to assemble. Most amateur builders, though, labored for thousands of hours, in part because the BD-5 was sold without a drive train. Jim Bede also never found a reliable engine for the BD-5, and by 1979 his company was bankrupt. Peter K. Graichen and Albert C. Beckwith donated their BD-5, fitted with a Honda automobile engine, to the National Air and Space Museum in 1984; the aircraft is now on display at the Steven F. Udvar-Hazy Center at Washington-Dulles airport in northern Virginia.

others are the sole usable photographic documentation of items previously seen only in illustrations, reproductions, or photographs of poor quality.

Desind taught middle- and high school science at Laurel High School in Maryland, which founded the Herb Desind Memorial Space Awareness Center in his honor. Desind was also a freelance writer and lecturer on space history, frequently using his collection to supplement his presentations. In addition, he built and launched more than 11,000 model rockets.

Researchers can arrange an appointment to access the collection by calling (202) 633-2320 or writing to: National Air and Space Museum Archives, National Air and Space Museum, MRC 322, PO Box 37012, Washington, DC 20013-7012. The collection is not available digitally, but its index can be found online at *www.nasm.si.edu/research/arch/*.

—Kelli B. Grant

Many of the Desind images were taken at Cape Canaveral in Florida, including a payload-bearing Atlas (above) and a Snark guided missile.

HERBERT S. DESIND COLLECTION (ACC 1997-0014)

MUSEUM CALENDAR

August 4–25 U.S. Air Force Band summer concert series, every Wednesday at noon. Music selections draw from a variety of styles, including big band, jazz, pop, and country. Air Transportation Gallery, 100.

August 6–28 Twelve Seconds That Changed the World. This 15-minute play is part of the National Air and Space Museum's newest exhibition, The Wright Brothers & the Invention of the Aerial Age, which commemorates the centennial of flight and examines the lives and work of the Wright brothers. Appearing on stages built into the exhibition, actors bring Wilbur and Orville Wright to life, along with their sister, Katharine Wright. The Wright family members recollect their lives, then writer Franz Kafka shares his astonishment at the feats of fliers at aeronautical shows, which became a worldwide rage only a few years after the Wrights' first flights. Every Friday and Saturday at 11:30 a.m., noon, 12:30 p.m., 1:30 p.m., and 2 p.m. Gallery 209. For information, call (202) 633-2400 or TTY (202) 357-1505.

Visitor Information

Location The National Air and Space Museum is located on the National Mall, along Independence Avenue SW, between 4th and 7th Streets, Washington, D.C. The Steven F. Udvar-Hazy Center is at 14390 Air and Space Museum Parkway, Chantilly, Virginia, near Washington-Dulles International Airport.

Hours Both the Museum on the Mall and the Udvar-Hazy Center are open from 10 a.m. to 5:30 p.m. every day except December 25. Admission is free.

Shopping The Museum offers visitors a three-level, 12,000-square-foot store full of air- and space-theme books, toys, collectibles, and multi-media and educational products. A selection of the Museum store's items can be purchased online at *SmithsonianStore.com*.

Except where noted, no tickets or reservations are required. To find out more, visit www.nasm.si.edu or call Smithsonian Information at (202) 357-2700, TTY (202) 357-1729.

Basic Instinct

In 1955, the biggest thing Yuma, Arizona, had going for it was its Air Force base. While stationed there as the technical representative for a jet engine manufacturer, I hung out with the squadron maintenance officer, Lieutenant David Skolinski, with whom I shared office space. The previous night, Skolinski had been to Winterhaven, a still-smaller town across the river in California, with strip joints lining both sides of the main drag. This morning he was paying for it. "Gawd, my head hurts," he complained. I told him he was lucky that after a visit to Winterhaven, a headache was his only medical problem.

That was the day the U.S. Air Defense Command was holding a rocketry meet at Yuma. Interceptor squadrons had arrived days earlier to practice. Lockheed F-94C Starfires, North American F-86D Sabrejets, and Northrop F-89D Scorpions would compete by firing at targets towed by North American B-45 Tornado medium bombers.

The F-89D carried a total of 104 2.75-inch-diameter folding-fin aircraft rockets, nicknamed "Mighty Mouse," in two pods, one on each wingtip fuel tank. These FFARs were unguided—it was hoped they would "fly" in a nearly straight line from a computed aim point to their target. The target area covered by the simultaneous firing of all 104 rockets was the size of a football field. It was assumed that an enemy bomber within that field of fire would be a near-certain kill. In the interests of economy, the competition required only 12 rockets to be loaded into each pod, so a broadside would consist of 24 rockets. Still, that would cover a lot of sky.

On the day of the finals, I learned that I was assigned to fly in one of the towplanes, which would be piloted by Skolinski, along with a copilot and a tail gunner, who would operate the tow reel. The last flight crew had written up, or "squawked," the airplane for a general vibration; it seemed to emanate from an engine, so I was brought in. Since there had been no detectable vibration during our run-up, we would have to evaluate it while towing a target.

We taxied out and started the interminable takeoff roll (the Tornado was, like its namesake, a real ground-lover). The climb to tow altitude went on and on and on, which gave me plenty of time to evaluate the vibration problem. Happily, I found it was caused by a misrigged wing flap—nothing to write home about. Now I was just along for the ride, on a pretty, bright day in the desert.

After the arduous climb, we were ready to deploy the target, a nine- by 45-foot banner with radar reflectors that the interceptors' fire control systems could lock onto. Skolinski pulled the aircraft up into a near-stall so we could get the target out from the bomb bay without straining the tow cable to the breaking point. Then we unwound 5,000 feet of cable and commenced our runs.

We heard "Thirty seconds" from the incoming F-89D. Some seconds later I saw out my left window a speck that was growing rapidly and ominously larger. Skolinski also saw it. The F-89 was boring in on us.

I made myself comfortable in the bombardier's seat in the nose and took in the excellent visibility. I had been in this seat on many other tows, so I was familiar with the routine: The interceptor should approach from my left, at a 90-degree angle to our flight path. The radar operator of the two-place interceptors—or the pilot of the single-seat F-86Ds—would be plotting everything out on a collision course for the target we were towing. That is, they would be firing from one point in space to another, which was as yet unoccupied by the target, but soon would be. At least that's the way it was supposed to work.

After a while, we were supposed to hear the interceptor say "Judy" on our radio, which meant that things were progressing normally and the fire control system was locked on, in command, and essentially flying the aircraft. Then, a call of "Thirty seconds" would signify that automatic firing would soon occur. A "Tally-ho" would mean the interceptor had us or the target in sight. Next, we were to hear "Five seconds" followed by "Splash," which meant the rockets had fired and were headed our way.

From my position, in the nose, I should never see the interceptor aircraft at all. He was supposed to be firing at a target that was nearly a mile behind us.

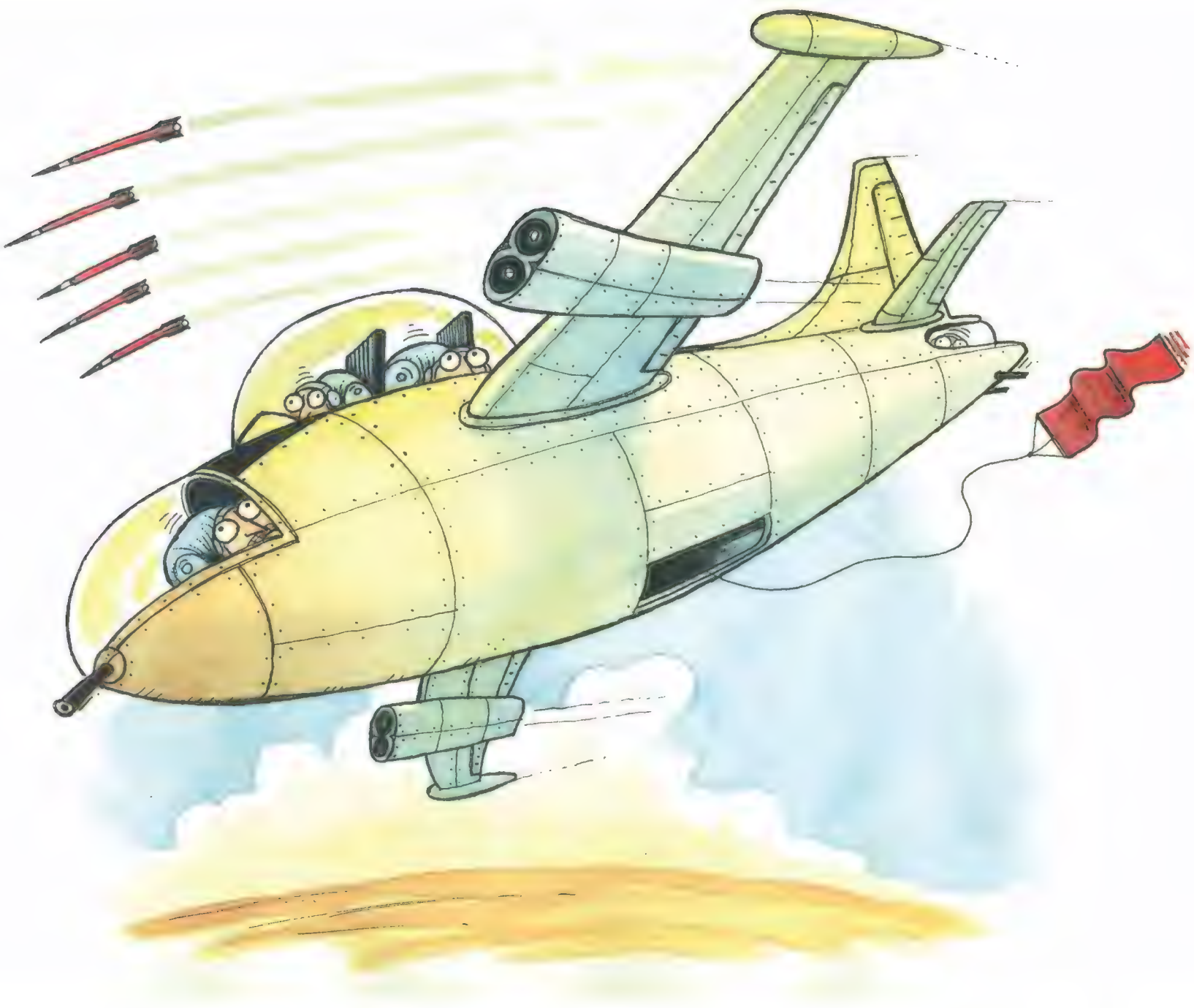
We heard "Thirty seconds" from the incoming F-89D. Some seconds later I saw out my left window a speck that was growing rapidly and ominously larger. Skolinski also saw it. The F-89, automatic fire and all, was boring in on us.

"Five seconds" from the attacking Scorpion. Skolinski began yelling "Break! Break!" at the pilot, trying to get him to terminate the attack. Then: "Splash!"

At the same instant, I saw black smoke bloom from his rocket pods. (Curiously, the smoke then seemed to go backward, back into the pods, as in a movie being shown in reverse.)

The damned F-89D had fired at us. His Hughes APG-40 radar was locked on our towplane instead of the target.

It was lunchtime at the Yuma Air



DAVID CLARK

Force Base Officers' Club when a lot of its excellent corned beef sandwiches got caught in a lot of constricted throats. The initial word was that a B-45 had been accidentally shot down by an F-89. And further, "that civilian"—me—was on board.

Actually, a garbled radio transmission said that an F-89 had shot a load of rockets at the B-45 instead of the target. This was further garbled by the chain of word-of-mouth transmissions until it reached the Officers' Club as: The B-45 had been shot down.

We started back, in a state near shock. Not one of the 24 rockets had hit us. If the F-89D had been carrying the full load of 104 rockets, it might have been a different matter. All I thought during the few seconds between rocket firing and anticipated impact was "Here I am wearing my penny loafers instead of my heavy, high-top flight boots. If I even get the chance to bail out, my loafers are going to pop off when the chute deploys and I'll be hotfooting it across the scorching Gila Desert in my stocking feet."

Things got worse, when, after firing his rockets the F-89 pilot broke the wrong way and struck our tow cable. The collision ripped off his canopy (and very nearly both his and the radar operator's heads), as well as slicing off a few feet of the aircraft's vertical stabilizer.

Both airplanes managed to land safely back at the base. I learned to my dismay that some well-intentioned friend had contacted my wife and passed on the hearsay that I had been shot down. When I walked into the house, she looked at me as if I were a ghost. To this day, I'm unsure if my now-ex-wife had looked relieved or disappointed.

A board of officers was duly convened to investigate the incident. The board called us in and interviewed us individually. After the interviews, we B-45'ers compared notes—and guffawed when we realized that we had responded identically to one particular question.

Each of us had been asked: "What evasive action did you take, or observe being taken, when you became aware the rockets had been fired at your aircraft?"

We had each demonstrated how we had involuntarily hunched our shoulders and ducked our heads—the total evasive action taken by the highly trained B-45 crew.

That night, Skolinski went back to Winterhaven and, for the first time, I joined him.

—O.H. Billmann

Unfriendly Persuasion

USAF

In an audacious cold war plan to trounce the Soviet Union, fleets of U.S. bombers—at the time, B-36s—would carry out the "pressure" phase with nuclear weapons.

For a young, academically inclined Air Force officer, Colonel Raymond S. Sleeper caused quite a stir in the cloistered meeting rooms of 1954 Washington. The Soviet Union had just developed the hydrogen bomb and seemed poised to take over the world. But Sleeper offered a plan to dominate and, if necessary, eliminate the Russian threat. He called it Project Control.

An Air War College instructor, Sleeper had studied the methods used by Britain's Royal Air Force in the 1920s and '30s to keep rebellious colonial natives in line through the constant threat—and occasional actual use—of aerial bombing and strafing. Sleeper reasoned it might be possible for the United States to control the Soviet Union in much the same way.

In the midst of Cold War anxieties, Sleeper's study quickly grew into a huge enterprise, run by the war college and involving hundreds of military and civilian scholars, that culminated in an ambitious proposal to force an overhaul of the Soviet Union in an ultimate test of air power.

In the initial "persuasion" phase, Moscow would be presented with ultimata to withdraw from occupied territories, free political prisoners, and even dismantle the Communist Party, while armed reconnaissance aircraft continuously flew overhead, intimidating the Kremlin. If the Russians refused to mend their ways, the United States would proceed to the "pressure" phase: actual military action in graduated steps—including, if necessary, a nuclear attack.

This wasn't quite a new idea; some politicians and military leaders had been quietly discussing the notion of a "preemptive" strike since August 1949, when the Soviets experimentally exploded their first A-bomb. U.S. Army War College professor Tami Davis Biddle points out that many believed "it's a them-or-us deal, a zero-sum game." Communism and capitalism were mutually incompatible and headed for the ultimate showdown. And if war was indeed inevitable, shouldn't we strike first, rather than allowing the Soviets to grow ever stronger?

Project Control set out a grand rationale for such a strategy. The pressure phase would systematically erode Soviet ability to resist or strike back by hitting various strategic targets until the Kremlin capitulated. Then the final phase, "administration," could begin, in which a new government would be installed in Russia that would abide by U.S. rules and eventually move toward full democracy.

Throughout the summer, Sleeper gave his elaborate four-hour Project Control briefing to all who would listen, finding sympathetic audiences among military officials and contractors. They embraced it as an alternative to the ennui that seemed to pervade U.S. policy. Biddle explains: "There was a lot of frustration within the military about our inability to translate military power into political leverage." Sleeper showed how America could maneuver proactively instead of simply reacting to Soviet moves.

Despite strong backing by Department of Defense staffers, Strategic Air Command head Curtis LeMay, and the Joint Chiefs of Staff, Project Control didn't impress most civilian policymakers. While Central Intelligence Agency director Allen Dulles expressed guarded interest, the Department of State's Robert Bowie protested that the Soviet Union's response to such aggressive tactics was dangerously unpredictable. The state department's chilly reception likely prevented Project Control from ever reaching President Eisenhower's desk, but most believed that Ike would have rejected the idea on both moral and political grounds.

Project Control enthusiasts were undeterred, however, and later in 1954 the plan was tested in an Air War College academic exercise. It didn't go well. The Red Team, representing the Soviets, strongly resisted the Blue Team's "persuasion" and reacted rather less favorably than Sleeper had predicted. "The Soviets actually waged war on us before we got to wage war on them, which was not the preferred outcome," Biddle says.

That outcome, and the strong opposition to preventive war, essentially killed Project Control, but some of its ideas lived on. Sleeper's concepts may have inspired later reconnaissance overflights of the Soviet Union, including even the CIA's U-2 flight program.

Though it never became policy, Project Control gave cold warriors a moment to imagine the United States as undisputed world overlord. As late as 1965, Curtis LeMay rued the project's demise in his memoirs: "It would have been possible, I believe, for America to say to the Soviets, 'Here's a blueprint for your immediate future. We'll give you a deadline of five or six months…to pull out of the satellite countries, and effect a complete change of conduct. You will behave your damn selves from this moment forth.'

"We could have done this," LeMay concluded, perhaps wistfully. But few other insiders regretted that Project Control never proceeded beyond the inner sanctums of Washington.

—Mark Wolverton

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BEACHED STAR

How hopes for hot sales of a turboprop twin ran aground.

A few years ago, Starship pilot Bob Bass was flying at 31,000 feet over Kansas when he received a radio call from a U.S. Air Force jet that wanted to pull alongside. He looked out the window and saw a $2 billion B-2 bomber join up on his wing. The B-2 pilot was shooting photographs of Bass' airplane.

by Mark Huber

Last summer Starship owner Bob Scherer and I landed in Phoenix, and as we taxied up to the terminal, a pair of excited line service workers pulled cameras out of their pockets and began snapping away. "This happens all the time," Scherer said.

Twenty-five years after it was first conceived, the Beech model 2000 Starship is still a head-turner, its sleek, futuristic design looking as if it's doing 400 knots standing still. Last year, parent company Raytheon Aircraft announced that it had purchased most of the fleet, wanted to buy the rest, and would destroy all it could find, calling the cost of continued product support "prohibitive."

Most of the fleet sits on Evergreen Air Center's heavy-

maintenance ramp in Marana, Arizona, where the airplanes are being stripped, sawed up, and incinerated. Raytheon has donated a few of them to museums, but as of last May, only four Starships remain in the hands of private owners. Scherer, a southern California real estate developer, is one of them. "From my cold, dead hands will Raytheon get this airplane," he says, echoing the National Rifle Association's battle cry. "I would have nightmares if they sawed this plane up."

Raytheon sees no alternative. "Many parts on that airplane are unique to the Starship and are no longer being made by suppliers," says Raytheon spokesman Tim Travis. "From a business standpoint it was a losing proposition and it always would be."

But the Starship was flying in turbulence from the outset. For an industry in which designs have traditionally evolved in gradual increments, the new turboprop was the loudest of thunderclaps and completely antithetical—bold, daring, and radically different. From the shape of its airframe, to the placement of its engines, to its carbon-fiber structure, to its digital avionics, almost nothing about this airplane was normal.

The Starship was one of the largest and most advanced business aircraft programs ever attempted, and it bombed. When Raytheon shut down the production line in 1995, only 53 aircraft had been produced. "I had the joyous duty of shutting down the ill-fated Starship line," former Beechcraft president Roy Norris said in a 2002 interview published in

CHAD SLATTERY

End of the line: Raytheon's reclaimed Starships on the Evergreen ramp at Pinal Airpark in Marana, Arizona.

SHIP

NASM (SI NEG. #9A02244)

Piaggio's P.180 Avanti was launched in 1979 and first flew in '86. Mostly traditional metal construction, it has a unique three-surface configuration with both canard and tail. The company was moribund until 1998, when Ferrari acquired it and injected new funding. Sales recently began to take off.

The Learfan (right) combined all-composite structure with two turboshaft engines driving a single pusher prop through a gearbox. The Starship proof-of-concept craft (below) was an 85-percent scale version.

NASM (SI NEG. #9A02243)

General Aviation News. Referring to the television series "Star Trek," Norris said, "I made myself a promise that there would be no more airplanes that look like Klingon battle cruisers."

Bob Scherer flies serial number NC-51. (Beech serial numbers begin with two seemingly random letters, but some think NC signified "New Concept"; others think it was a play on the United Federation of Planets' starship registration from "Star Trek.") He thinks the Starship's revolutionary design and price tag hurt early sales. "It wasn't accepted at first because it was so radical," he says. "Plus it was five million bucks, which is entry-level jet zone." Scherer acquired his Starship from the Tyco Corporation in 1998 after seeing it listed in *Trade-A-Plane*, a thrice-monthly newspaper filled with ads for aircraft. A Starship on the market today would fetch about $2 million.

The Starship would have pushed the technology envelope for any aerospace company, but Beech was especially conservative. Seeking to replace its highly successful but 15-year-old King Air line, Beech decided in 1979 to develop a turboprop that would help preserve its lead in the business turboprop market, in which it held a 50 percent share. The goal was an airplane that could cruise at 400 mph, carry 10 passengers, and weigh less than 12,500 pounds. (By comparison, a King Air 350 cruises at 360 mph, seats two pilots and eight passengers, and has a basic empty weight of 9,300 pounds.)

According to a personal account of the airplane's development by former Beech chief executive Max Bleck (*Starship History; www.aviatorservices.com/starship_history_1.htm*), the company studied designs that ranged from the traditional to the radical, seeking an airplane that delivered jet-like performance at cheaper turboprop operating

costs. Soon one design emerged, with aft-mounted pusher engines and a wing with vertical surfaces at each wingtip. It also had a large cabin, one of the King Air's most appealing features, but its size would make it heavy. "The decision was made early on to build using composites for [their] favorable strength-to-weight ratio," Bleck wrote.

By the late 1970s, other companies were working on similar or competing concepts, spurred in part by spiking oil prices. In Reno, Bill Lear's widow, Moya, was trying to finish his Learfan. It had a composite fuselage with twin turboshaft engines mounted in the tail and driving a four-blade pusher propeller. Italian airframe maker Piaggio teamed with Learjet (then owned by the Gates Rubber Company) on a design that became the P.180 Avanti. The Learfan never made it to market, and Gates bailed out of the Piaggio program. The P.180 is in production today and has finally started selling, thanks largely to Italian government subsidies and the deep pockets and patience of Piaggio's owners, the Ferrari family (yes, that Ferrari). During the 1970s, Cessna, Mitsubishi, Piper, Swearingen, and Rockwell fielded successful conventional twin-engine turboprops.

BREEZEWAY

Composite wizards Bill Brown (left) and Ric Abbott with Beech's giant autoclave and its product: a fresh-baked part for a Raytheon Premier bizjet.

Beech saw its domination of the business turboprop market slipping away, and on January 30, 1980, its engineering department issued a closely held report entitled "Advance Design Comparison Studies of Several Unconventional and Conventional Corporate Turboprops and Fanjets." Months later, Raytheon, a Massachusetts-based electronics firm, acquired Beech Aircraft, and it was not until August 1982 that the program resumed. Advanced projects engineer Bill Brown remembers the day well. "Chet [vice president of engineering Chester Rembleski] gets us all together, turns off the lights, and shows us this movie. In the movie this guy is climbing up a mountain and you hear him breathing and see him slipping on the rocks and clawing with his hands. He is really struggling, but not saying anything. Then he gets to the top of the mountain, puts on his skis, and skis down the side of the mountain. He goes like hell. Then the lights come up. We're all sitting there puzzled, looking at each other, and Chet says, 'Gentlemen, we are going to design a new airplane and we are going to do it in two years.' " The project was initially labeled 300A, perhaps to suggest it was a new King Air, and later Starship 1, and then model 2000. It was shrouded in secrecy, and most Beech employees thought Brown's team was working on the next King Air.

By the late 1960s, composites had begun to find their way into aviation, initially in sailplanes. Beech's own research showed that carbon fiber was at least three times stronger than aircraft aluminum. In the California desert's Antelope Valley, next to Edwards Air Force Base, a young engineer named Burt Rutan was designing aircraft with a small forward wing, or canard, that made his aircraft more aerodynamically efficient and virtually spin-proof. (When some aircraft fail to maintain sufficient airspeed to produce lift, they have a tendency to stall and enter a spin.) His first design, the VariViggen, used wood. Then he started looking at fiberglass.

Bill Brown was a homebuilt-aircraft enthusiast who had already worked with composites—in his garage. He began making sketches of what a Rutan design would look like if it were morphed into a business aircraft. Beech then approached Rutan about joining the design effort. The company's designers explored numerous configurations, including pushers, twins, and one like the Learfan, before finally selecting one Rutan had drawn on a napkin. According to both Rutan and Brown, it was not until Raytheon entered the picture that the project, originally conceived by Beech in 1979, really took off.

The aircraft's systems would be as radical as its shape. The Starship would break all the rules: It was the first business aircraft with an all-glass digital cockpit—a group of 14 cathode-ray tubes in the instrument panel. Rockwell-Collins was tasked with developing this system, called EFIS, for electronic flight information system. The Starship was the first civilian aircraft with a pressurized carbon-fiber fuselage to be certificated by the Federal Aviation Administration, the first modern U.S.-built production civil aircraft with a forward wing or canard, the first without a tail, and one of the first passenger turboprops with pusher propellers (Piaggio was the other).

The program brought together some of the finest minds in aviation. They included D. Brainerd Holmes, a driving force behind NASA's Apollo program and now president of Raytheon. Linden Blue and composites guru Ric Abbott came aboard from Learfan; Blue is credited with selecting Rutan's design. Others involved included Rutan and a handful of brilliant aerodynamicists, including John Roncz, an airfoil expert, David Bernstorf, who led the Beech aerodynamics and

BREEZEWAY

BREEZEWAY (2)

An eye magnet, the Starship's silhouette was altered only when the canards swept forward as flaps deployed. The glass cockpit (left) was engineered by Collins.

loads group, Roy LoPresti, a speed merchant who had wrung the drag out of half a dozen airplane types, and Brown. At its apex, 1,000 employees were assigned to the Starship, 450 of them engineers.

Beech's parent company, Raytheon, would spend a million man-hours and $350 million (early 1980s dollars) bringing the airplane to market and hundreds of millions more marketing and supporting it. Some estimate that Raytheon sank as much as $1 billion into the program. (Raytheon will not provide an exact number and may not even know what it is.) "The cost was a very nebulous figure to come up with," says former Beech and Raytheon president Max Bleck. "None of our financial people tried to put a pencil to it." But almost everyone knew that the numbers didn't add up. An internal economic analysis by Beech in 1979 concluded that if it sold 400 Starships a year at an after-tax profit of $250,000 per unit, for a total profit of $100 million a year for 30 years, it would generate an internal rate of return of 16 percent at a time when the prime rate was almost 20 percent.

When he was president and chief executive of Beech, from 1987 to 1991, Bleck, a former Piper Aircraft president, ran the numbers and tried to bury the Starship program. "I tried to kill the airplane twice," Bleck says, first in 1987, just months before the aircraft received type certification, and again in 1991. On both occasions, he was overruled by his bosses at Raytheon.

In 1982, the Rutan Aircraft Factory was awarded a contract to build a proof-of-concept Starship for aerodynamic testing. Working around the clock, Rutan's crew built the airplane, which was slightly smaller than the production version, in less than a year. Beech exhibited the POC aircraft at the National Business Aircraft Association's 1983 convention in Dallas and announced the aircraft's target price: $2,742,500. The response was a collective gasp. This was potentially the biggest new thing since the Learjet.

Skeptics doubted that the aircraft would make its aggressive two-year certification schedule, that it would come in under 12,500 pounds gross weight, and that it would win

acceptance from a conservative market. They were right. The Starship would not gain FAA certification until 1988. Its empty weight would increase by 2,400 pounds and its gross weight would balloon to 14,900 pounds. Originally designed for a pair of 750-shaft-horsepower engines, the weight gain forced designers to adopt thirstier 1,200-horsepower engines. The diameter of the propellers would grow from 94 inches to 105 inches. It also lost two passenger seats. And by the early 1990s the price would inflate to $5.3 million. Despite the excitement and the aura Rutan brought to the project, the button-down world of business aviation was not ready for an airplane that had become a moving target.

For the skeptics, including those at Raytheon, the proof-of-concept aircraft became the focal point of criticism. The POC was unpressurized, made of fiberglass rather than carbon fiber, and had a higher thrust-to-weight ratio than the production aircraft. Critics deemed it too different to be proof of anything. Bleck called the POC "virtually worthless." Rutan and others, including Bill Brown and Beech test pilot Tom Carr, disagree. Intended to fly only 100 hours, the POC would log more than 500 between 1983 and 1986 and provide important data that affected the final design. Rutan got the POC contract on August 25, 1982. Beech started designing tooling for the production Starship six days later. Had the POC flown before tools for production aircraft were built, its impact on the Starship could have been far greater. After the POC program ended, Raytheon had the airplane destroyed in full view of those who had built it. Rutan's staff salvaged a few mementos, including the data plate.

As tensions grew between Rutan and Beech, they also increased between Beech and Raytheon. Beech's genteel culture buckled under the often abrupt ways of its new parent. Since 1950, Beech had been run by Walter Beech's much younger widow, Olive Ann. Mrs. Beech would put yellow "happy face" stickers on the office doors of meritorious executives. Company picnics were courtly, civilized affairs.

It wouldn't be long before the Raytheon clamps were tightened. The old ways were gone, Mrs. Beech stepped aside, and the door to the president's office began revolving. Occupants were either kicked upstairs to corporate headquarters in Massachusetts or shown the door. During the Starship's development, from 1982 to 1989, Beech had three presidents and four engineering vice presidents, creating certification delays and performance compromises.

Initially, Brainerd Holmes brought in Linden Blue from Learfan as president, largely to run the Starship program. Blue, today co-chairman of General Atomics, maker of the Predator unmanned aircraft, would last two years. Brown remembers Blue as a "real go-getter," but others described him as a micromanager who insisted on locating the Starship's lavatory in the front of the cabin (the toilet was in a cabinet-mounted drawer that pulled out into the aisle, a design that would later be changed), nixed an external baggage compartment door, and thought that spraying water repellent on the windshield would substitute for wipers. Brown counters that the wipers disrupted airflow, and the repellent worked fine except during taxi operations.

The Starship also stirred up cultural wars within Beech itself. From the beginning, the project was an enormous drain on company resources and capabilities, fostering resentment among those involved with other Beech programs. The Starship team was housed in its own brand-new, 150,000-square-foot building and seemed to get the best of everything.

Explains Max Bleck, "People working on the rest of the product line felt the Starship was using most of the resources." The Starship was burning $500,000 a day. "It was insane," says Tom Carr. "Money was going out the door at an incredible rate." When big layoffs hit the rest of Beech in 1984, the "have nots" turned their anger on the Starship. "That caused a lot of problems for a lot of years," says Carr.

The Starship also created a fair amount of anguish on the

Desktop models serve as a record of the many configurations Beech conjured (below). Test pilot Tom Carr visits a Starship airframe preserved at the Kansas Aviation Museum in Wichita.

RAYTHEON

BREEZEWAY

manufacturing side of the company, which was wise to the ways of metal airplanes but uncertain about composites. Brown recalls that the first three airframes were fabricated using a mechanized process in which carbon fiber material was automatically wound around a form, or mandrel, by a winding machine—the most advanced technology at the time. Too advanced, Brown says, though it could cut time and cost. As the material traveled through the winding machine, it picked up thick liquid resin from a reservoir and squeezed out the excess using rollers. The Utah company doing the winding was used to doing prototypes and one-off projects, not volume production. "Ed Hooper [chief of airframe design] stayed up for 32 hours straight watching that first winding operation," Brown recalls. "Then he crashed in his motel room." Hooper liked the winding process, but Brown says the technology "just wasn't there"; the tooling kept failing. At airframe NC-4, Beech switched to hand "lay-up" of carbon fiber material that was already impregnated with resin, or "pre-preg." Workers cut sheets of this material using a template and laid them in a mold, the direction and angles of the overlapping carbon fibers matching the path of loads in the part and determining its strength. A light, strong honeycomb core was sandwiched between two layers of carbon sheets and compressed to eliminate voids. After spending time in the heat and pressure of an autoclave to cure, the part was done.

Tom Carr looks back at the Starship's complex supply chain and marvels that the aircraft ever got produced. Rutan was building the POC in Mojave. Bell Helicopter was building the canard in Fort Worth. Brunswick, the bowling ball company, had the initial contract for the control surfaces, but never delivered a usable tool or part, Brown recalls. Pratt & Whitney was making the engines in Montreal. Hercules was manufacturing composites in Utah. The propellers were coming from McCauley in Ohio. Collins was developing the avionics in Iowa. TKS was working on anti-icing technology in the United Kingdom. Precision Components was fabricating the fuselage mockup in Detroit. The list goes on. "We didn't have the composites technology or a lot of the other technologies either," says Carr. "We ended up contracting parts of the airplane with people all over the world." But too many parts ended up coming back to Beech's plant in Wichita at a time when the technologies were new and the rulebook was being written.

To keep the ballet coordinated, a fleet of King Airs flew

Mojave, California: The proof-of-concept craft was demolished by Raytheon crews.

SCALED COMPOSITES

MARK HUBER

Starship owner Bob Scherer (right) shared a flight with Burt Rutan—the designer's first hop in the aircraft.

engineers around the country several times a week. But it was inevitable that the supply chain would collapse. Internal engineering memos show major assemblies and components sometimes being delivered months late. Computers of fiendish complexity operated systems such as environmental controls, cabin pressure, and automatic deicing, and engineers struggled with all of them, even naming one Hal after the robot gone bad in the film *2001: A Space Odyssey*. They were replaced with simpler systems, but delays mounted up.

Amazingly enough, the first full-scale production prototype, NC-1, made its first flight a mere 28 months after the Starship was announced. On February 15, 1986, Carr and chief test pilot Bud Francis lifted off from the snow-lined runway at Beech Field. Below the pilot's window was a heart-shaped decal, a valentine for Olive Ann Beech—one day late. The first flight was replicated for Beech employees and the media later, and two more aircraft would join the test program. Between the airplane's conception and June 14, 1988, the day it received its FAA type certificate, Bill Brown personally signed 50,000 change orders on more than 2,000 engineering drawings. Major changes were being made to the aircraft through the end of May 1988. Brown saw nothing wrong with that. "Change iteration is the way you maximize an airplane," he says. Management had a different opinion. Down $350 million and counting, it wanted the airplane on the market. Now.

"If it is certifiable, certify it," was the edict from Bob Dickerson, Beech's vice president of engineering, in 1988. In the rush, fixes were not done optimally, often with weight gain as a result, while other fixes were not done at all, such as remedying the Starship's light pitch sensitivity and heavy, almost truck-like roll response. "The FAA did have some issues, and we ended up with a belt-and-suspender type of approach that was an expedient solution," says Bernstorf.

The results were disastrous for the aircraft's early reputation. While Beech had gotten most of the difficult new technology right—from the avionics to the composite structure to the variable-sweep canard—it had let a lot of mundane, old-technology things fall through the cracks. The first production Starship, NC-4, was delivered to a Florida-based beer distributor at the summer 1989 Paris Air Show. The air conditioning on the airplane failed repeatedly. Other common problems included door seal failures, defects

BREEZEWAY

in bleed air valves supplying pressurized air, and bad brakes. Starships were tarred as "hangar queens," and one exasperated operator took a Beech executive to lunch and ordered a special centerpiece—a bowl of lemons. Beech eventually fixed these problems, and airplanes with later serial numbers had few if any problems, but in the death-by-whisper world of business aviation, the damage was done.

"What killed that airplane was the reliability issue," says Tom Carr, who flew 30 of the 53 units produced and logged hundreds of hours training customers. "Once it got that reputation, it was hard to sell airplanes." And Beech sold its own direct competition: the King Air series, airplanes that flew almost as fast, carried as many as two more passengers, and were known for almost bulletproof reliability. At the 1992 NBAA convention, Beech's then-president, Jack Braley, told reporters that Starship production would end at serial number NC-53 if sales didn't pick up. "That was the kiss of death right there," says Carr. Production ended three years later, at serial number NC-53.

Carr thinks that if Beech had held the Starship off the market for a year to address weight, reliability, and handling issues, "they would still be building Starships today." Although considered a commercial failure, the Starship project, for those who worked on it, remains the experience of a lifetime. Prior to the Starship, Ric Abbott had worked on high-profile European programs like the Concorde and the Tornado fighter. Even today, he calls the Starship "my favorite program. It was a great time."

The Starship became a flying object lesson in marketing business aircraft: Product perception is everything.

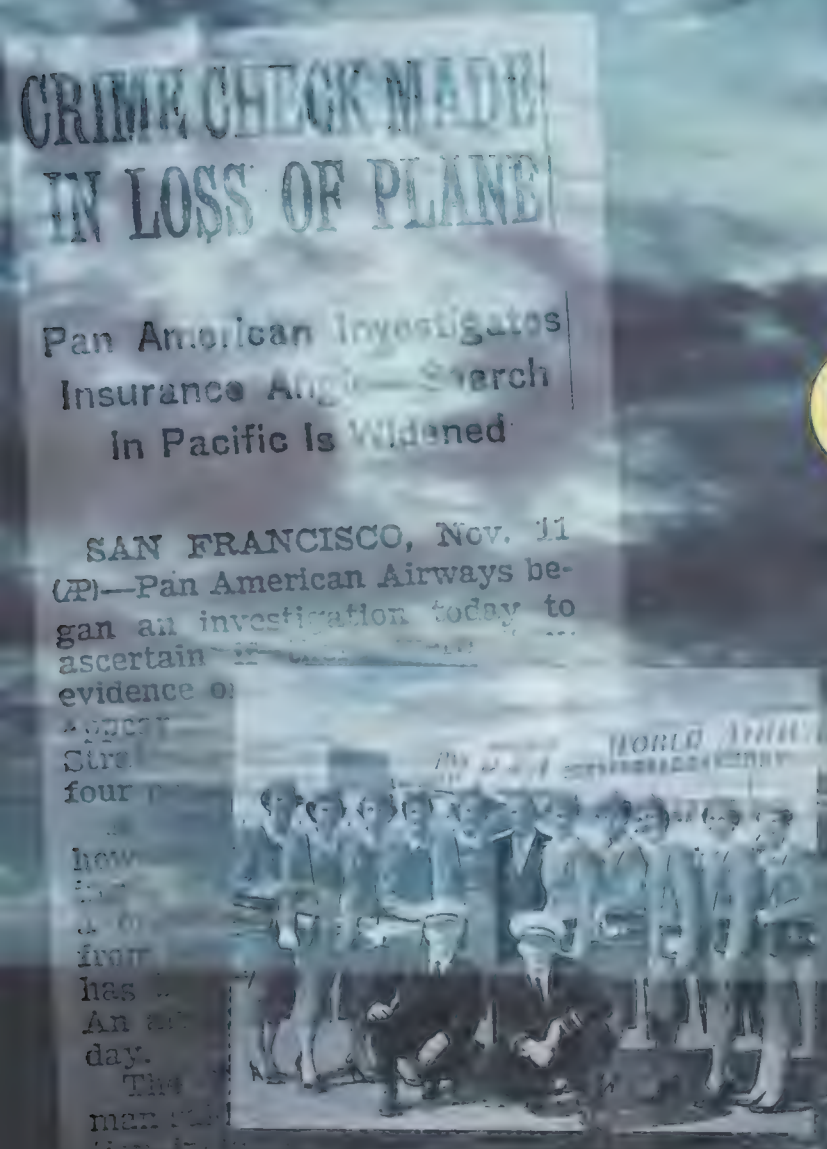
Those lucky enough to fly Starships are similarly enamored. Corporate pilot Wayne Roberts has logged 2,500 hours in Starships over nine years for several owners. He has flown over 60 types of aircraft, but he says nothing handles turbulence better. Since 1995 Bob Bass has logged 1,900 hours in Starships as a corporate pilot for Vertex Aerospace in Madison, Mississippi. "It's a wonderful airplane to fly, very maneuverable and plenty of power," he says.

On a broiling summer day, Bob Scherer and I taxi NC-51 up to Burt Rutan's hangar in Mojave, unannounced. A crowd gathers to greet us, and one of them calls out, "You're not giving it back [to Raytheon], are you?" Rutan is busy but greets us warmly. To our amazement, we discover that Rutan has never flown in a production Starship, so he, his test pilots, and Scherer pile in and take off. They climb to altitude and shut down an engine, pull full aft stick, and try to spin the airplane—it won't. After they land, Rutan pulls out a felt-tip pen and autographs the inside of NC-51's coat closet. As we leave, someone calls after Scherer, "We'll fix it if you break it."

Flying back to Los Angeles, Scherer says, "I'm a convert to this design. I couldn't fly a metal airplane with a tail in the back. Uh-uh. It just seems wrong."

A Pan Am Stratocruiser's
plunge into the Pacific killed all witnesses
and confounded investigators.
Can the authors finally
crack this cold case?

The Mystery of the Lost Clipper


CRIME CHECK MADE IN LOSS OF PLANE

Pan American Investigates Insurance Angle—Search In Pacific Is Widened

SAN FRANCISCO, Nov. 11 (AP)—Pan American Airways began an investigation today to ascertain

by GREGG HERKEN *with* KEN FORTENBERRY

This is a ghost story. For the past 46 years, the two of us—Ken, a newspaper publisher, and me, a history professor—have been haunted by what happened to Pan American Airways Flight 7 early in the evening of November 9, 1957. The airliner, *Clipper Romance of the Skies*, was on the first leg of a round-the-world journey that began earlier that day in San Francisco. Its next stop was to have been Honolulu, but the Boeing 377—known by the airline as PAA-944—never arrived. It crashed in the Pacific, killing 44 people, including Ken's father, second officer and navigator Bill Fortenberry, and flight attendant Marie McGrath, who had been my fourth grade teacher.

Our class was told that the big four-engine Boeing Stratocruiser had simply vanished, but the biggest air-sea search since the disappearance of Amelia Earhart would end just days later with the discovery of 19 bodies and floating wreckage about 1,000 miles northeast of Honolulu. And the little that was recovered from the flight only deepened the mystery.

Three anomalies confounded Civil Aeronautics Board crash investigators: There was no decipherable distress call received from 944; the location of the debris showed that the Clipper was well off course and headed away from a Coast Guard ship that could have helped; and, finally, elevated levels of carbon monoxide were found in several of the recovered bodies. Further inquiry by authorities implicated three suspects in the loss of the aircraft. The mystery of *Romance of the Skies* was, in effect, an airborne Agatha Christie thriller—*Murder on the Orient Express* at 10,000 feet.

In January 1959, after an unusually long investigation, baffled CAB officials found "no probable cause" for the crash, and formally closed their inquiry. Informally, Ken and I have reopened it, with the hope of bringing 21st century technology to bear upon this nearly-50-year-old mystery, and to finally discover what happened to a father, a favorite teacher, and the 42 other souls on board *Clipper Romance of the Skies*.

After the FBI forsook the case, Pan Am and the Civil Aeronautics Board found no probable cause for the 1957 crash. Nearly a half-century later, PAA-944 still closely guards its secrets.

OPPOSITE CENTER: NASM (SI NEG. #97-17098)

Like the fabled B-314 flying boat that preceded it, the Stratocruiser was an aircraft unmatched in size, speed, and luxury when Boeing introduced it to the world's airlines in 1947. Dubbed "the ocean liner of the air," the B-377 featured Pullman-style sleeping berths, separate men's and women's dressing rooms, and a horseshoe-shaped cocktail lounge in the belly of the airplane. Reclining seats doubled as sleeperettes and offered an amazing 60 inches of legroom. Seven-course dinners, beginning with champagne and caviar, were served on china. Meals for first-class passengers on transatlantic flights were catered by Maxim's of Paris.

The loss of Clipper Romance of the Skies *was heartbreaking for the families of flight attendant Marie McGrath and navigator Bill Fortenberry.*

Even laden with heavy appointments, the "Strato-clipper" was faster than its two commercial rivals, the Douglas DC-6 and the Lockheed Constellation. Four Pratt & Whitney R-4360 B6 Wasp Major engines—the biggest piston engines ever put into production—gave it a top speed of 350 mph and an unmatched capacity for payload, as much as 30,000 pounds. When 944 left the gate at San Francisco's International Airport shortly before noon for the nine-and-a-half-hour flight, its cargo hold was stocked with luggage, mail, movie film, radioactive medicine, and a new IBM computer.

The 38 passengers aboard the Clipper reflected the socioeconomic status of those who could afford the $300 ticket to Hawaii or the $1,600 round-the-world fare (equivalent to $10,500 today). Robert LaMaison, the vice president of Renault Auto and a World War II French air ace, was on vacation with his wife Nicole. William Hagan, a prominent Louisville surgeon, and his wife Norma Jean were on their way to a medical conference in Honolulu. H. Lee Clack, the general manager of Dow Chemical in

Tokyo, was headed home with his wife Anna, sons Bruce and Scott, and two adopted daughters, Kimi and Nancy. Edward Ellis, the vice president and general sales manager of a spice company, was beginning a tour of his firm's overseas plantations. Soledad Mercado—a Phoenix dress designer better known as "Soledad of Arizona"—hoped to find new customers abroad.

Those on *Romance* that day also included the mundane—and the mysterious. A deadheading Pan Am pilot, Robert Alexander, had planned a fishing trip to the islands with his wife and their two children. Twenty-four-year-old William Deck was en route to Kyoto to marry a Japanese woman he had met while in the U.S. Navy. Foreign service officer Thomas McGrail was bound for Rangoon, Burma, and an assignment as cultural attaché at the American embassy there. U.S. Air Force Major Harold Sunderland's final destination remains somewhat unclear. Sunderland belonged to the 1,134th Special Activities Squadron and was on an undisclosed mission to southeast Asia with a briefcase full of classified documents. The Air Force would later describe Sunderland in a press release simply as an "information gatherer."

In command of 944 that day was 40-year-old Captain Gordon Brown, a 15-year veteran of the airline. Bill Wygant, the first officer, had been with Pan Am for more than a dozen years. The young flight engineer, Al Pintara, was taking night courses in electronics at a community college in anticipation of promotion. The senior flight attendant, Yvonne Alexander, was a statuesque blonde who also took care of her ailing father in San Francisco.

Ken's father, navigator Bill Fortenberry, 35, was an avid outdoorsman who enjoyed taking his young sons to Yosemite on weekend hiking and fishing trips. Abandoned by his mother while in his teens, Bill had been taken in by a South Carolina farm family and originally planned to be a minister, but he had a yearning to fly, so he took a part-time carpentry job after college to pay for the lessons. He was a religious man, and his sons remember him telling them that once a man has flown over the clouds and gazed upon the Earth below and the heavens above, he could never doubt the existence of God.

Stewardess Marie McGrath, 26, was an energetic brunette whom friends would remember as "pretty" and "pert." Even while she was attending Keuka College in upstate New York, Marie had dreams of someday flying for Pan Am. Under her graduation picture in the college yearbook is the inscription "Wanderlust...air-minded...California."

During her three-week layovers between round-the-world flights, Marie worked as a substitute teacher at my elementary school in San Mateo, California. When our regular teacher went on maternity leave, our class came to know and love Miss McGrath, who one day held a "luau" for us kids. We were all secretly sad when our regular teacher returned to work and Marie went back to flying.

At 4:04 p.m. local time, from an altitude of 10,000 feet, Captain Brown radioed a routine position report to the *Pontchartrain*, a Coast Guard weather ship stationed in the Pacific to assist over-flying aircraft. *Romance*

Twenty-five victims were never found, including Bill Fortenberry. For years, his son Ken believed the navigator was awaiting rescue on a desert island.

of the Skies had just passed the point of no return and was on course and schedule, 1,160 miles from Honolulu and about 10 miles east of the *Pontchartrain*. The skies were clear and the seas calm, with the sun low in the western sky. Onboard the Clipper, Yvonne Alexander and Marie McGrath had just started serving hors d'oeuvres when something terrible happened. Twenty-two minutes later—wristwatches found on three recovered bodies had stopped at 4:26 p.m.—944 hit the water.

Debris from 944 was eventually found 90 miles to the north of the flight's intended track, suggesting that the airplane continued to fly for some time after the mysterious incident occurred. Fourteen of the 19 bodies recovered were wearing life vests but no shoes, indicating that some preparations had been made for ditching. (Yvonne Alexander's body was found still strapped to its seat, a life vest carefully fitted over her serving apron.) Floating fragments of the fuselage and cabin indicated that the airplane hit the ocean with the nose slightly down and the right wing lowered. Although several of the recovered bodies exhibited "impact trauma," according to the CAB report, the fact that most died from drowning suggests that 944's final plunge into the sea was not completely uncontrolled. The wreckage had burn marks; these were above the waterline, indicating a post-crash fire, but there was no evidence of an inflight conflagration.

Pan Am and the FBI suspected foul play. Suspicions grew when autopsies uncovered high levels of carbon monoxide in four bodies. The gas was found in the bloodstreams of Captain Brown and passengers who had been seated in the front as well as the rear of the airplane, suggesting that the carbon monoxide had been widely distributed.

For years afterward, whenever an airplane went down under "mysterious circumstances," I would think of *Romance of the Skies* and Marie McGrath. On my first day at work at the National Air and Space Museum, in 1988, I asked my new colleagues in the aeronautics department about the B-377 and its reputation. But my job as chairman of the department of space history left me little time for research. In 2002, shortly before I left NASM, I finally began to seriously investigate the incident.

The revelation that I was not alone in my search came suddenly—like the discovery of footprints on a supposedly deserted beach—when I typed "Romance of the Skies" into an Internet search engine and came up with Ken's Web site on the crash. After a short correspondence and several phone calls, Ken and I decided to join efforts.

Ken had begun his investigation almost 40 years earlier. As a child, he'd become convinced that his father was still alive on a desert island awaiting rescue, but on the tragedy's seventh anniversary, he realized that his father wasn't coming home. He wrote a letter to the CAB's chairman saying he wanted some answers about his father's death, and the CAB responded by sending him a copy of its report. Even as a 13-year-old, he thought the report was incomplete. Not a week goes by that he doesn't file a Freedom of Information Act request or try to chase down another angle.


SEATING CHART SHOWS SEATS AS ASSIGNED TO PASSENGERS FOR DPTR SFO

C-1 RAINBOW 24 PRESIDENT — B-377 SEAT-BERTH CHART — TRIP SEVEN08 DATE NOV 8, '57 — USE PENCIL ONLY

DECK · DURAL · JONES · RODRIGUES · ROWLAND · CREW RAINBOW · PRESIDENT · SULLIVAN · QUONG · DERBIJL · BOYD · CHOY · PAYNE · LAMAISON · BARBER · ALEXANDER · HAGAN · HAGAN · CLACK · CLACK · COLE · SUNDERLAND · SULLIVAN · ALEXANDER

The New York Times Nov 10, 1957

AIR-SEA SEARCH ON FOR AIRLINER LOST WITH 44 IN PACIFIC

Craft on Flight to Honolulu From San Francisco Last Heard From Friday

NO DISTRESS SIGNALS

Air Force Reports Sighting of Yellow Objects That Could Be Life Rafts

Aboard Airliner Missing at Sea

Gordon H. Brown, pilot of plane lost in the Pacific.

Robert L. Lamaison, head of Renault auto unit here.

By The Associated Press

HONOLULU, Nov. 9—Planes and ships crisscrossed the seas west of Honolulu today seeking traces of a Stratocruiser missing since last night with forty-four persons aboard.

The Coast Guard cutter Minnetonka was searching an area about 1,000 miles toward the mainland.

It was in this area that an Air Force search plane sighted three yellow objects, possibly life rafts, bobbing on the seven-foot seas.

The point was eighty miles southwest of the last position reported by the Hawaii-bound transport, Romance of the Skies. The last word from the plane was at 5:04 P. M. Pacific standard time (8:04 P. M. Eastern standard time) yesterday.

There were no frontal storms reported along the plane's flight path. The transport had run into headwinds but they were not strong.

Objects May Be Tanks

The Air Force plane was taking part in a wide sea-air search. It sighted the objects earlier today.

Capt. D. B. MacDiarmid, chief of Coast Guard operations, said it was possible the yellow objects were not rafts but wing tanks jettisoned by a jet plane.

He said there was a "potent possibility" the plane "suddenly and for an unknown reason went out of control."

The four-engined plane, after passing the "point of no return" halfway along the 2,400-mile flight to Honolulu from San Francisco, vanished without reporting any trouble. The airliner's fuel supply was estimated to have given out at 3 A. M.

Wide Area Searched

The Minnetonka was part of a search party of more than twenty-nine planes and fourteen surface vessels covering a

a charted checkerboard of 65,000 square miles.

A four-engined search plane that developed engine trouble returned safely to its Honolulu base tonight. One engine was leaking oil. Another four-engined search plane, one propeller feathered, was being escorted back to base. The Coast Guard said it was in no danger.

Comdr. William E. Chapline of the Coast Guard pointed out that a ditched plane should have been able to flash some distress signal during a twenty-minute descent from 10,000 feet.

The New York Times Nov. 10, 1957

The Pan American Stratocruiser with forty-four aboard was reported missing in Pacific at a point (cross) more than 1,000 miles east of Honolulu. Plane was traveling route from San Francisco, shown by solid and broken lines.

Could purser Eugene Crosthwaite (left) have killed Captain Gordon Brown, Renault V.P. Robert LaMaison, and 41 others?

Independently, we had both researched 944 on the Web site of the CAB's successor agency, the National Transportation Safety Board. The NTSB archives provided a passenger manifest and the basic facts of the investigation. Ken was able to get more details about the people who had been on *Romance of the Skies* by mining hometown newspaper "morgues," and through the Freedom of Information Act, we obtained the FBI file on 944, which revealed a surprising—and disturbing—twist to the story.

On November 18, 1957, as the aircraft carrier *Philippine Sea* docked at Long Beach with recovered bodies and wreckage, a dockside dispute between CAB representatives and FBI agents concerning who had jurisdiction in the case blossomed into a full-fledged feud between the rival agencies. In retaliation, FBI director J. Edgar Hoover washed his hands of the investigation. Ignoring pleas from both the airline and the head of the CAB, Hoover left the question of determining whether a crime had been committed up to Pan Am and the board, whose investigatory capabilities were considerably less than the bureau's.

We began our own inquiries by posting questions on a pair of Web sites maintained by former Pan Am employees, asking for information about 944's crew members from those who might have known them. We were

OPPOSITE TOP: NASM (SI NEG. #00129509)

BOB WHALEN VIA NICHOLAS VERONICO

Romance of the Skies—here in a 1952 publicity shot—and other 377s set the standard for air travel until eclipsed by Boeing's 707 jet.

surprised to be deluged with responses from more than two dozen pilots, navigators, flight engineers, and flight attendants. And we learned from them that the airline, back in 1957, suspected one of its own.

Former colleagues revealed that 944's 46-year-old purser, Eugene Crosthwaite, had previously been in trouble with Pan Am for erratic and sometimes bizarre behavior. Crosthwaite once bragged that he had deliberately dropped a meal on the galley floor before serving it to an unsuspecting captain, who he felt had insulted him. Furthermore, Crosthwaite blamed Pan Am for several misfortunes, including the tuberculosis he'd contracted in Shanghai before the war, while serving as a purser on the airline's flying boats.

Though fully recovered from the disease, Crosthwaite had been despondent following his wife Julie's death from cancer three months earlier. She was a raven-haired beauty some 13 years younger, whom he had met and married in China. Her death had left Gene the sole guardian of Tania, his wife's 16-year-old daughter from a previous marriage.

Relations between Crosthwaite and Tania were stormy. On November 3, just days before the flight, Crosthwaite had called the county sheriff's office to complain about the girl, whom he called "a demon" and blamed for his wife's death. Crosthwaite even amended his will the morning of the flight—disinheriting Tania unless she "lived a moral and upright Catholic life"—and left a copy of the document in the glove compartment of his car, which he parked at the airport.

Pan Am considered the changed will a smoking gun—an indication that Crosthwaite had planned to die. The CAB too assigned one of its investigators, Claude Schonberger, to look into Crosthwaite's background. Schonberger's investigation seemed to strengthen the case against the purser. According to his report, Crosthwaite's father-in-law remembered the suspect showing him a handful of blasting powder a few days before the flight, and despite an exhaustive search, neither Schonberger nor the purser's father-in-law could find the explosive on Crosthwaite's property after the crash. For Schonberger, the most damning evidence was a chance remark that Tania made to the sheriff. The sheriff testified that Tania thought it "probable that [Crosthwaite] might have taken his life and destroyed the 40-odd passengers on the flight 'because he was too chicken to go alone.' "

But just as Pan Am seemed ready to conclude, 10 months after the tragedy, that the purser did it, a new suspect suddenly entered the case. William Harrison Payne, 41, listed as a passenger on *Romance of the Skies*, was reportedly on his way to Hawaii to collect an overdue debt. Payne owned the Roxbury hunting lodge, outside Scotts Bar, California, a small town near the Oregon border. Among the more curious details about Payne—whose body was not recovered—was the fact that the purported debt amounted to less than the price of the one-way ticket to Honolulu he had purchased. Even more remarkable was the fact that Payne had taken out a total of three life insurance policies on himself—one of which paid double in the event of accidental death—shortly before the flight. The two most recent policies, from separate companies, would pay a total of $125,000 to his wife Harriet, and had been purchased only three days prior to 944's departure. But perhaps the most arresting aspect of Payne's life was his career before becoming an innkeeper: he had been a Navy frogman—a demolitions expert.

Payne's story came to light in the pages of the *San Francisco Examiner*, under the banner headline "Blast Plot Hinted in Mid-Pacific Air Crash." The source for the story was Russell Stiles, an investigator for Western Life Insurance Company. Pending the results of Stiles' inquiry, Western Life was withholding payment to Payne's wife on the $10,000 double-indemnity policy Payne had bought two weeks before the crash. Upon learning of Payne's background, Stiles had gone to the FBI and, frustrated by the bureau's inaction, had alerted the *Examiner*'s crime reporter.

Stiles' investigation only deepened his conviction that Payne had brought the airplane down to collect the insurance money, and had in fact never been aboard *Romance of the Skies*. Stiles discovered that the suspect had previously been in trouble with the law for trying to collect tolls on a public road used by logging trucks. Threatened with arrest, he had set off a dynamite charge in the road, making it unusable. Payne had also fired three shots at a business associate for reasons no one could discover and was overheard to boast that he could build a delayed-action detonator using only a length of wire and two flashlight batteries.

After interviewing people who had known Payne, Stiles also discovered a possible motive for the crime: Payne owed his mother $10,000 for the hunting lodge, which was losing money and was up for sale.

As Stiles dug, the story got even stranger. In June 1958, seven months after the loss of 944, Harriet Payne got married in Tijuana to a friend and former neighbor of her husband's. Two days later, while the newlyweds were still on their Mexican honeymoon, the heavily insured Roxbury Lodge burned to the ground. Although the authorities suspected arson, the insurance underwriters, faced with the prospect of a lawsuit from Harriet, quietly agreed to settle the claim. Meanwhile, the postmistress in Scotts Bar told Stiles, in confidence, that Harriet and her new husband had begun receiving mysterious letters and packages from overseas. There was never a return address.

In the late 1970s Ken tracked Stiles down to a small mountain town in Colorado. He refused repeated requests for a personal interview, but his daughter told Ken that Stiles had never been satisfied with the outcome of the official inquiry into 944. Even after retiring from Western Life, he had continued his investigation of Payne, using his own funds. Stiles remained persuaded that Payne was not only still alive, but likely in a vengeful mood. According to Stiles' daughter, until the day he died, in March 1999, her father feared that he would one day answer the door and look into the hateful stare of William Payne.

While Pan Am suspected Crosthwaite, and Western Life fingered Payne, some CAB investigators blamed another culprit.

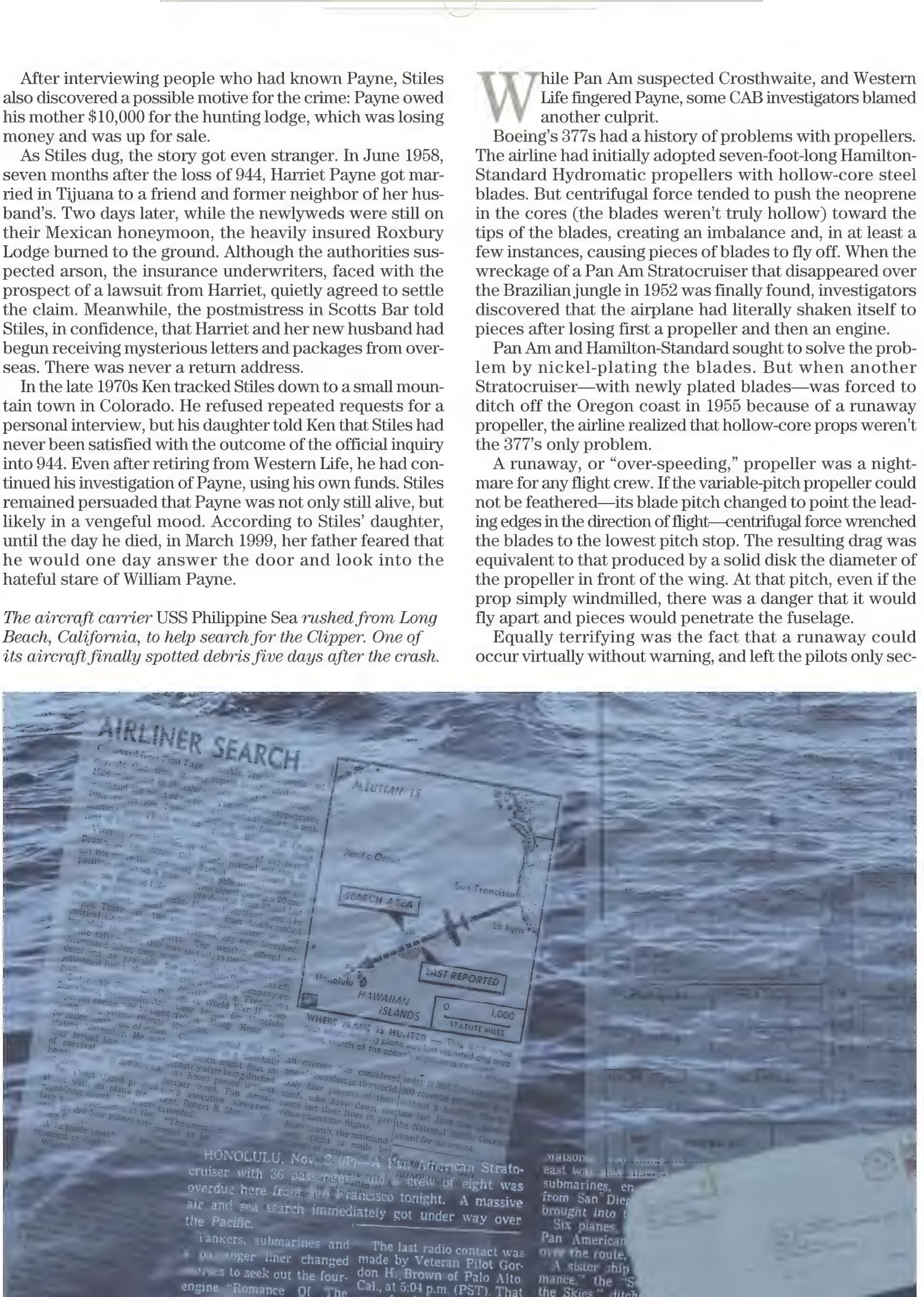
Boeing's 377s had a history of problems with propellers. The airline had initially adopted seven-foot-long Hamilton-Standard Hydromatic propellers with hollow-core steel blades. But centrifugal force tended to push the neoprene in the cores (the blades weren't truly hollow) toward the tips of the blades, creating an imbalance and, in at least a few instances, causing pieces of blades to fly off. When the wreckage of a Pan Am Stratocruiser that disappeared over the Brazilian jungle in 1952 was finally found, investigators discovered that the airplane had literally shaken itself to pieces after losing first a propeller and then an engine.

Pan Am and Hamilton-Standard sought to solve the problem by nickel-plating the blades. But when another Stratocruiser—with newly plated blades—was forced to ditch off the Oregon coast in 1955 because of a runaway propeller, the airline realized that hollow-core props weren't the 377's only problem.

A runaway, or "over-speeding," propeller was a nightmare for any flight crew. If the variable-pitch propeller could not be feathered—its blade pitch changed to point the leading edges in the direction of flight—centrifugal force wrenched the blades to the lowest pitch stop. The resulting drag was equivalent to that produced by a solid disk the diameter of the propeller in front of the wing. At that pitch, even if the prop simply windmilled, there was a danger that it would fly apart and pieces would penetrate the fuselage.

Equally terrifying was the fact that a runaway could occur virtually without warning, and left the pilots only sec-

The aircraft carrier USS Philippine Sea *rushed from Long Beach, California, to help search for the Clipper. One of its aircraft finally spotted debris five days after the crash.*



onds to react. Often the first indication of a problem was a sudden change in propeller noise, from the normal dull throbbing to a rapidly ascending, blood-curdling whine. One Pan Am pilot likened the sound to "the cry of a thousand banshees."

A year earlier, an over-speeding propeller and engine failure had forced 944's sister ship, PAA-943, *Clipper Sovereign of the Skies*, down on its way from Hawaii to San Francisco at nearly the same spot *Romance of the Skies* crashed. After circling until daylight, *Sovereign* ditched next to the *Pontchartrain*. All 31 passengers and crew were able to evacuate the airplane before it sank.

Curiously, the final CAB report on 944 paid little attention to earlier Stratocruiser over-speeds and claimed that *Romance of the Skies* never had an over-speeding incident. But a telephone call from one of our Pan Am veteran contacts, a gruff-voiced, 90-year-old Irishman and former B-377 pilot named Clancy Mead, contradicted that claim.

Mead recounted that he had been at the controls of *Romance of the Skies* when the airplane experienced a runaway propeller on a flight to Hawaii in June 1957, barely six months before its fatal plunge into the sea. Unable to feather the prop on the no. 3 engine, and losing altitude at a rate of 100 feet per minute—even with the remaining engines at rated power—Mead turned 944 around and headed back to San Francisco. He estimated that *Romance* cleared the mountains along the coast by only 500 feet. Luckily, he was able to set the airplane down safely at the airport.

What may be the last pieces of the puzzle came to Ken and me from two more veterans, Frank Garcia and Tony Vasko, who contacted us when word of our search got around on aviation-related Web sites. For decades, Garcia, the flight engineer on *Sovereign* when it ditched in 1956, has suspected that the cause of *Sovereign*'s runaway prop was a small part in the engine nose case needed to move oil to the prop dome (see illustration, opposite). A failure of the oil transfer tube or the bearing connecting it to the dome would make it impossible to feather the blades on that propeller. But conclusive proof of Garcia's theory remains inaccessible on the ocean floor. Tony Vasko was the director of overhaul at Eastern Airlines until he retired in 1990. An expert on aircraft engines and propellers, Vasko is a frequent contributer to technical journals and aviation magazines. He found evidence that Pan Am, the manufacturers, and the Federal Aviation Administration had recognized, by the time of 944's accident, that the transfer tube—which was brazed, rather than bolted in place—represented a potentially fatal flaw on the 377. Thus, an emergency "AD"—Airworthiness Directive—issued by the FAA in early 1957 warned: "As a result of propeller shaft oil transfer bearing failures, several cases of loss of propeller control occurred which make it impossible to feather the affected propellers." The directive ordered that the brazed joint be inspected on every engine and either replaced or repaired "not later than May 31, 1957."

But Clancy Mead's 944 prop runaway had occurred June 18, 1957—more than two weeks after the compliance date had passed. This seems to confirm claims by several Pan Am veterans that maintenance standards had slipped at the airline, which was rapidly losing money on the posh Stra-

Pan Am's Stratocruisers were configured to seat four crewmen in a spacious cockpit. This ghostly portrait of 944's right wing was snapped by one of its former pilots.

CENTER: COURTESY CLIFFORD PIERCE; UPPER LEFT: BOEING/DISC 00014449

tocruiser and had already announced plans to replace the 377s with jets.

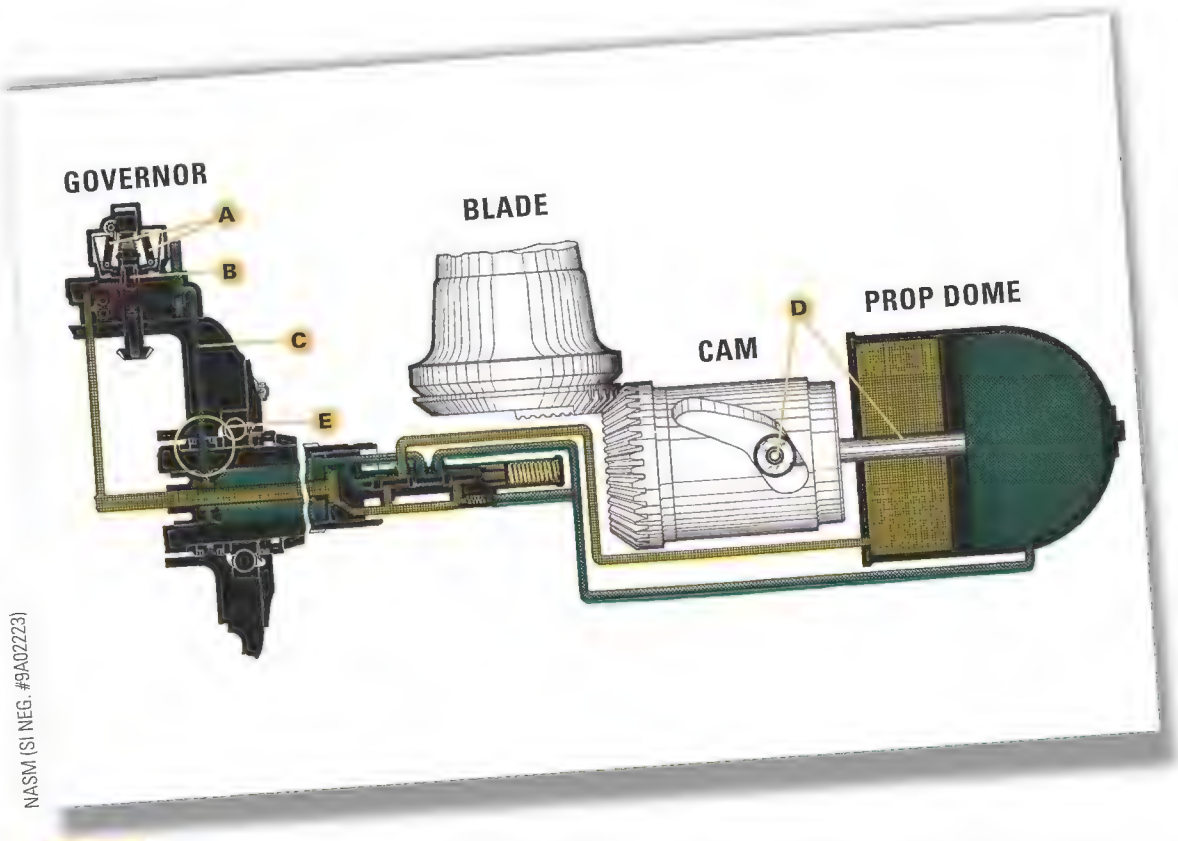
The problem with the oil transfer bearing was soon corrected, thanks to subsequent ADs. But had it been fixed before *Romance of the Skies* took off on its final flight?

The near-half-century that has passed since the loss of 944 has made it possible to rule out some of the theories that had been put forward at the time of the crash. For example, Japanese pathologists in the 1980s—fearful that the high incidence of drunk businessmen falling off their boats and drowning was the handiwork of organized crime—confirmed that excess carbon monoxide, the forensic discovery that had worried CAB investigators as they first looked for causes of the crash, can be the result of natural decomposition in warm saltwater. But there is still no smoking gun that would allow Ken and me to say we have solved the mystery.

Ocean charts indicate that the resting place of 944 is at a depth within the range of today's miniature subs. Deep-sea submersibles of the sort that discovered the resting place of the *Titanic* could almost certainly answer the question of whether *Romance of the Skies* broke apart from the aerodynamic stresses caused by a dead engine, or whether a disintegrating propeller pierced the cabin and started a fire, also knocking out communications.

But without a *Titanic*-like expedition, our next best hope lies in finding an audio tape that has become the Holy Grail of our search. Our Pan Am friends have told Ken and me about a tape recording of radio transmissions from aircraft transiting the Pacific that day. The recording, which was entered into evidence at the CAB hearing on 944 back in 1958, seemed to include a last desperate "Mayday" from *Romance of the Skies* after all. Pilots who had known the airplane's crew claimed that, upon repeated playbacks, they could hear a faint, garbled message on the tape. Pan Am had appealed for help to Bell Laboratories, which, after analyzing the tape for three months, concluded that it contained no recognizable words.

Thanks to computers and the cold war, however, signal analysis has made giant strides over the past several decades. Digital processors have replaced the oscilloscopes of the 1950s. Recently, experts at the National Transportation Safety Board were able to deduce the cause of a helicopter crash by listening carefully to a recording of the pilot's frantic radio calls. In the background, almost too faint to be heard, was the telltale sound of a failing gear. When the wreckage was pulled up from the bottom of San Francisco Bay, the NTSB's hypothesis was confirmed.



NASM (SI NEG. #9A02223)

The governor inside a constant-speed propeller helps translate engine power to blade pitch. Gyrating flyweights (A) in the governor are driven by the engine. When the engine's power is increased or decreased, the change in centrifugal force causes the L-shaped flyweights to open or close an oil flow valve (B), which controls the amount of oil flowing through the oil transfer tube (C) into the prop dome. Inside the dome, pressure from the oil shifts the piston-and-roller assembly (D), which twists the cam to adjust the pitch of the blades. If oil drains from the prop dome—perhaps due to a failure of the oil transfer ring (E), which connects the oil transfer tube to the spinning prop shaft—centrifugal force wrenches the spinning blades to their lowest angle of attack, perpendicular to the air flow. This condition makes it impossible to feather the blades. Without resistance from the blades—which aren't doing any work—the engine drives the propeller too fast, causing it to over-speed.

The archivist at Lucent Technologies—formerly Bell Labs—says that both Lucent's copy of the tape and the report done for Pan Am have likely been destroyed. Pan American Airways went out of business in 1991, and the University of Miami now owns its records. The bulk of those—some 1,000 boxes—remains in storage at a former Navy base nearby. That collection is largely unprocessed and is currently off limits to researchers. But it is likely that the maintenance records for 944, Pan Am's internal investigation of Eugene Crosthwaite, and perhaps even the audio tape are all in that labyrinth of boxes.

The archivist at the University of Miami estimates that it will be at least three years before the Pan Am collection is processed and opened to researchers. NTSB representatives have expressed a willingness to reopen the investigation of *Romance of the Skies* if new evidence—or, in this case, old evidence that can be reanalyzed by new methods—surfaces.

If the tape is found, what might it reveal—if anything? An explosion? A struggle in the cockpit with a madman? Or the shrill, accelerating scream of a runaway propeller? When those boxes are opened, Ken and I plan to be there.

On August 23, 1954, Lockheed test pilots Stan Beltz and Roy Wimmer powered up the latest of their company's improbable designs, and after an 855-foot ground roll, pulled it up into the southern California sky on its first flight, bound for Edwards Air Force Base. Designated the YC-130A, the new airplane was the second of two prototypes built at Lockheed's Burbank plant. The aircraft looked nothing like its contemporaries. Its wings lay like a plank balanced on beefy shoulders. Power came not from great reciprocating radials but four General Motors Allison turboprops. Its aft fuselage sharpened to form a wedge capped by an enormous vertical fin. Its narrow landing gear dropped out of pods on the fuselage. Its flight deck lay beneath a multi-pane greenhouse and above a beak-like nose. It had an earnest, surprised, round face that only, as some have opined, a mother could love.

Indeed, by Lockheed standards, the newcomer was exceedingly plain; one might have asked how

A flock of C-130Hs flies over Japan, one of 60 countries smitten with the Hercules

50 YEARS OF HERCULES

LOCKHEED'S C-130 HAS BEEN IN PRODUCTION LONGER THAN ANY OTHER MILITARY AIRCRAFT.

by Carl Posey

KATSUHIKO TOKUNAGA/CHECK-SIX

JOHN ROSSINO/LOCKHEED MARTIN

a company that produced such glamorous aircraft as the Lightning, Constellation, Shooting Star, and U-2 could have brought forth the Hercules. But this ugly duckling would grow into something much greater than a swan. In time, the plangent roar of its engines would signal that help, in the form of food, fuel, medicine, materiel, or firepower, was at hand.

It began with a *Request for Proposal for Medium Cargo Airplane*, a modest document issued by the U.S. Air Force on February 2, 1951, during the first year of the Korean War. U.S. military transports then consisted of Fairchild's C-119B Flying Boxcar and the C-123 Provider, both powered by twin piston engines, and such World War II leftovers as the C-47 and C-54. Long-distance hauling was left to the four-engine C-124A Globemaster II, a huge double-decker fuselage astride a familiar Douglas wing. The Air Force asked for an airplane that would carry a 25,000-pound payload over a 1,150-mile radius of action, and 20,000 pounds for 2,530 miles.

The later A models, with their spacious "Pinocchio" radomes, marched down the Georgia production line in the late 1950s.

A probably apocryphal account has engineers at Ohio's Wright-Patterson Air Force Base measuring the interior of a railroad box car to size this imaginary airplane. "When we got the request," says Willis Hawkins, then with Lockheed's advanced design department, "Hibbard [Hall J. Hibbard, Lockheed's chief engineer] asked us to look it over." At the time Lockheed's only four-engine design was the Constellation. For the C-130, Hawkins says, "there was no preceding model. A clean piece of paper."

Hawkins and his team sized the new airplane around high-use equipment. The height (nine feet) and width (10 feet) of the cargo compartment accommodated the Army's M5A-3 High-Speed Tractor with its top gun stowed. Length was based on what a 1.5-ton truck and semi-trailer would need: 41 feet. "We saw to it that the structure had no obstructions to loads coming in the back door," Hawkins says. "It was designed to be used in a tactical situation where there weren't any nice, clean places to take care of it.

"We picked a turboprop engine, which was pretty new for those days," he says. "We thought the powerplant would have a lot of stretch in it. Propellers were high to keep the powerplant out of the dust and dirt. Narrow undercarriage so you could operate from roads. Getting paratroopers out, dumping loads, dictated where to put the doors." There was never any thought of a forward ramp of the kind on the C-124. "A nose door got you all involved with the cockpit," Hawkins explains.

With design in hand, Hawkins and his team went to Hibbard to have their proposal approved. "We had a small model, 15 inches. 'Has Kelly seen this?' Hibbard wanted to know," referring to Clarence J. "Kelly" Johnson of Skunk Works fame, then Hibbard's assistant. " 'Kelly better see it before we send it in.' Nobody'd seen Kelly in weeks, but he came in. He looked at the model, then he looked at Hibbard. 'Hibbard,' he said, 'if you send this proposal in, you'll destroy the Lockheed Company.' Kelly didn't like it because it didn't go Mach 3 or shoot or drop bombs," Hawkins says. "But we finally con-

vinced Hibbard: The thing is due, we have to get it mailed today. So we did. And lo and behold, we won."

On July 2, 1951, Lockheed was awarded a contract for two prototypes. Just over a year later, the Air Force asked for seven production airplanes—this nearly two years before Beltz and Wimmer made their first flight in the prototype. The company moved C-130 production from Burbank, where space was limited, to Marietta, Georgia. The town's confluence of railroads, which had attracted William T. Sherman as a potential supply line during his Civil War march to the sea, led World War II planners in 1942 to construct a sprawling aircraft factory. At its peak, the plant employed 28,000 people. Under license from Boeing, Bell Aircraft built 668 B-29s—what locals still call the Bell Bomber—between November 1943 and V-J day. Within a month of victory in the Pacific, however, the plant was closed, and the workers returned to the rural Georgia economy.

In January 1951, Lockheed came to the Marietta facility, first to refurbish more than 100 B-29 Superfortresses for action in Korea, then to build 394 B-47 Stratojet bombers under license to Boeing. When C-130A production began, the plant was still turning out B-47s on a parallel assembly line. In April 1954, the Air Force asked for 20 more C-130s, and then, in September, 48 more; a year later, it would order another 84. Hawkins may have been the only one who lost money on the deal. "The tactical air commander was a real enthusiast," he recalls. " 'The Air Force is doing this one right,' he said. We were hoping they'd buy maybe 200. 'I'll bet we'll buy more than 500 of these things.' I bet him five bucks, and lost."

A naming contest at the Marietta plant in the fall of 1954 brought in nearly 10,000 suggestions, with the favorite being "Griffin." Whether this referred to the fabled eagle-lion hybrid or to Georgia's then governor is not recorded, but Lockheed management opted for Hercules, the strongman of Greek mythology, with 160 votes; familiarly, Herk, or, intimately, Herky Bird.

The first production C-130A took off from a runway shared by Lockheed and Dobbins Air Force Base (now Air Reserve Base) on April 7, 1955, and, at Marietta, Edwards, and Florida's Eglin Air Force Base, the big transport was run through its paces. The most serious glitch was a mismatch between the Allison T56 engine and the Curtiss-Wright turbo-electric propellers, which had pitch-setting problems causing the engines to surge. A switch to hydraulically actuated props solved the problem.

Over time, the three-blade propellers were replaced by four-blade Hamilton Standards, the original Allisons by more powerful Rolls Royce Allison engines, and the "Roman nose" radome of the early A models by the "Pinocchio nose." Models were fielded with fuselages lengthened by as much as 15 feet. A commercial counterpart, the L-100, was put on the market.

But two things never changed: Riding in the cargo hold of a C-130 is still a class below steerage, and, from the first A model to today's spanking new J, from the first hour of flight to the 20 millionth, the airplane has been fun to fly. Pilots stepping up from piston-engine transports in the 1950s got roses in their cheeks when they flew the

LOCKHEED MARTIN

The U.S. Navy eyed the Hercules as a delivery truck for aircraft carriers. A Marine Corps KC-130F tanker made multiple landings on the USS Forrestal *in October 1963. By reversing its propellers, the tanker came to a stop in 300 feet—and backed up to take off again.*

PATRICK BUNCE/CHECK-SIX

The low-altitude parachute extraction system delivery employs a parachute that, when released, pulls pallets out of the cargo hold and drops them almost instantly. Trouble is, such a hard landing can shatter the cargo.

LOCKHEED MARTIN

The second of two YC-130 prototypes was rolled out and prepped for the first Hercules flight in August 1954 at Burbank. Smog forced a postponement of the planned 9 a.m. takeoff until late afternoon.

LOCKHEED C-130J SUPER HERCULES

50 YEARS OF AIRLIFT HERITAGE

ILLUSTRATIONS BY HARRY WHITVER

The C-130J is the most recent and advanced version of Lockheed Martin's legendary airlifter, which the company has sold to 60 nations. Designed around a crew of three through use of extensive digital automation, sensors, and mission-management systems, it is available in two versions, the J, with a 40-foot cabin, and the J-30, which has a 55-foot cargo hold that provides seats for up to 92 paratroopers and capacity for seven cargo pallets. It is fully night-mission-capable and can deliver cargo with pinpoint accuracy using its aerial delivery radar system and mission computers. The Super Hercules can refuel in the air and is delivered with an integrated defensive electronics system that senses and counters radar and infrared missiles with jamming and automatic chaff and flare dispensers. For more information, browse *http://www.lmasc.lmco.com/busdev/airlift/c130/c130j.html*

Glass cockpit

- Two-pilot flight deck, all-digital, liquid-crystal displays
- Dual mission computers
- Lighting compatible with night-vision goggles
- Holographic head-up displays
- Digital moving map display
- Laser-gyro inertial/GPS satellite/radio-frequency navigation management
- Built-in test equipment/maintenance fault recorder

Specifications

Crew 3 (2 pilots, 1 loadmaster)

Range 3,265 miles

Maximum ceiling 30,560 fe

Maximum cruise 401 mph (348 knots)

Maximum-performance takeoff run 1,800 feet

Landing distance 1,400 fee

Cabin volume J: 4,551 cubi feet; J-30: 6,022 cubic feet

Rolls-Royce AE 2100 turboprop engine

- 4,591 shaft horsepower
- Weight: 1,640 pounds
- Two shafts, 14-stage compressor
- Dual full-authority digital engine control
- Matched with six-blade Dowty R391 propeller

Advanced systems

- Hydraulics: 3,000 pounds per square inch
- Inflight refueling
- Electrical power: 5 AC 40-kilowatt alternators
- All-weather day/night precision radar-based automatic cargo delivery
- Cabin pressurization: 7.5 pounds per square inch
- Integrated defense system
- Dual-rail cargo system for pallets/containers
- Digital autopilot with autothrottle

JOHN ROSSINO/LOCKHEED MARTIN

C-130. Compared to its contemporaries, the Herk felt like a fighter. "Good roll rate, nimble," says Lieutenant Colonel Tom Powers, who flies C-130Es out of Pope Air Force Base in North Carolina. "You can get down in the valleys, follow the river bank. It's a smaller aircraft, so you get to be in harm's way. We get the flying missions the other, bigger aircraft don't."

While the Hercules had been created for the Korean conflict, it missed that war. Its destiny lay in the lush folds of Indochina. A decade of Vietnam service caused the airplane to be reinvented, then reinvented again. Add cannon and side-firing weapons to fuselage portals and you had a gunship. Roll explosive canisters out the ramp and you had a bomber. Add fuel hoses and you had a tanker. You could spray herbicides and cloud-seeding chemicals from it. You could drop flammables and fire-suppressants. Add instrumentation and you had a weather researcher and hurricane penetrator. Add catfish-like whiskers and you could snag a cable attached to a balloon and pluck downed comrades out of the jungle. But mainly the Hercules was how people got from airstrip to airstrip, and where isolated forward bases got much of the food, bullets, and reinforcements to keep them in business.

Soldier, sailor, tanker, spy: The Hercules' résumé lists dozens of roles. Here, a Marine Corps KC-130 refuels a CH-53E Sea Stallion. The oldest of the Marine Corps tankers, delivered in 1962, have been through four wars. Brand-new KC-130Js are on the way.

GEORGE HALL/CHECK-SIX

The emblematic C-130 trial was at Khe Sanh, a patch of ground held by Marines near the demilitarized zone separating the two Vietnams. The remote base came under siege in June 1967, and by the end of January 1968 was cut off from ground resupply. With the site encircled and pounded by enemy artillery, the situation bore a chilling resemblance to Dien Bien Phu, where in the spring of 1954 French troops had been surrounded, then shelled and starved into surrender. Thereafter, nothing came into Khe Sanh that did not come in by air, and much of that arrived aboard a Hercules. When they couldn't land, they dropped cargo by parachute. They also employed a dicey tactic called LAPES—low-altitude parachute extraction system—with parachutes rigged to pull containers out of the cargo hold just a few feet above the surface and drop them.

The Herk's long Vietnam career ended late in April 1975, when the last C-130 departed Saigon's Tan Son Nhut base. Around 9 a.m., Tim Nguyen, a former Vietnam air force officer (now a senior staff engineer at Lockheed Martin) and some comrades headed for the flightline, where they found the C-130 taxiing with its ramp down. They and many others scampered aboard. "This was a C-130A, three-bladed propellers, smaller engines," he recalls. "I don't think the pilot knew how many people were in the back. The loadmaster managed to shut the ramp. After takeoff, we were flying low for miles. We were afraid soldiers would shoot us down. When we landed at an American base in Thailand, I was almost at the back and got out first. I looked at the people coming out…452 people, 34 on the flight deck."

Vietnam was a decade-long defining moment for the Hercules. The transport's other oft-cited adventure lasted no longer than your average B-movie. On July 3, 1976, four Israeli Defense Force C-130s involved in Operation Thunderball flew 2,400 miles to Uganda, where members of the Popular Front for the Liberation of Palestine were holding about 100 Israeli passengers from a hijacked Air France flight. The Herks carried some 250 commandos, several well-equipped jeeps, and a black Mercedes sedan similar to dictator Idi Amin's personal vehicle. Approaching Entebbe near midnight, the lead Hercules, posing as an African airliner, was cleared to land. The other three followed close behind. The commandos moved out, led by the Mercedes, surprised the guards and hi-

BELOW: WFP/ALEXANDER JOE; LEFT: WFP/DEBBI MORELLO

Rising to the Herculean task of feeding the world's hungry, a United Nations World Food Program C-130 air-drops sacks of food, targeting a marker in Sudan.

LOCKHEED MARTIN

The U.S. Coast Guard flies long-range surveillance HC-130Hs bulging with rescue gear that can be dropped by parachute.

jackers, and rescued most of the hostages—two were lost in the firefight, and a few were wounded. An hour and a half after arriving in Entebbe, the last of the four Herks was airborne, heading for a refueling stop in Nairobi and then home.

An airplane that can do anything can't always do everything. In 1980, Operation Eagle Claw, an attempt to rescue Americans held hostage in Iran, self-destructed when a dust-blinded Marine Corps helicopter clipped one of six Herks waiting at a remote airfield code-named Desert One. A follow-on rescue scheme, Operation Credible Sport, added large retro-, lifting, and takeoff rockets to three C-130s, with the idea of landing commandos in a Tehran soccer stadium and flying the hostages out. During the first landing trial, the lift rockets failed to fire and the onboard computer triggered the upper retro-rockets prematurely, dropping the Herk to the ground. The crew got out, but the shattered aircraft was destroyed by fire. Before a second effort could be mounted, Iran agreed to free the hostages.

But the Hercules has pulled off stunts it was never designed to do. Lieutenant Jim Flatley, with Lieutenant Commander "Smokey" Stovall as copilot and aviation machinist mate Ed Brennan as flight engineer, landed a Marine Corps KC-130F on the flight deck of the USS *Forrestal* 18 times in the fall of 1963. (Visit *www.airspacemag.com*, Website, QT Sightings, "Hercules on Deck.") The Navy was toying with the idea of using the transport as a carrier resupply—the Grumman C-1 onboard delivery aircraft in use at the time had a limited range and could not carry oversize payloads. "It was like landing on a normal runway," Flatley reported in a 1999 issue of *Skypower* magazine, "but that big metal island was a bit scary." With the Herk on a painted centerline, the right wingtip was only 15 feet from the superstructure. Despite the absence of a tailhook, Flatley includes his *Forrestal* Herk landings in the 1,608 traps he made before retiring as a rear admiral in 1987.

The Hercules also retrieved data from spy satellites, though not with telemetry. In the 1960s, U.S. spy satellites overflying the Soviet Union and China shot their images on film, which they then dropped over the Pacific. Crews in JC-130Bs would disperse along the expected trajectory at 20,000 feet, find the descending capsule, which was the size of a trash can, with their radar, and begin trying to snag the parachute with hooks and a large rope net. "Our motto was 'Catch a Falling Star,' " recalls Al Blankenship, a retired master sergeant well-versed in C-130 satellite film retrieval systems. Crews made 40,000 recoveries, including operational and training catches. During Project Senior Bowl, Herk crews also caught an 800-pound data pack dropped by the Mach 3 D-21 ramjet-powered reconnaissance drone, initially launched by a modified A-12 (predecessor of the SR-71), and later by B-52 motherships.

Commando Solo Herks, festooned with antennas, are employed by the

Royal Air Force pilots exercise a C3 (C-130K, mid-1960s vintage). Aerial refueling probes on RAF Hercules extend their range to 5,000 miles.

Air Force Special Operations Command to monitor and sometimes override radio and television broadcasts, advising combatants how they can surrender, how slim their chances are, and when they can expect the next air attack. Compass Call, based at Davis-Monthan Air Force Base in Arizona, uses EC-130Hs modified with waist pods and a ladder antenna under the tail to disrupt enemy ground communications. Combat Shadow's main mission is refueling special-operations helicopters, low and slow, at night, during war. Combat Talon raises the bar on the "anything, anywhere" idea. "The C-130's ideally suited for our type of mission—covert infiltration, resupply, extrication, any weather, any terrain," says Major Bruce Taylor, who flies the Talon MC-130E. "I've taken this plane low-level through the Hindu Kush. Landed on the desert floor."

The Talon is not your father's Hercules. "We can go down to 175 feet without seeing anything outside, wingtips as close as 65 feet from the cliff wall," Taylor says. "We have sophisticated electronic countermeasures equipment, a terrain-following system, forward-looking infrared camera, self-contained instrument approaches, and the short-field capability of a normal C-130." The aircraft can drop the 15,000-pound BLU-82 and 21,700-pound Massive Ordnance Air Blast bomb. "Pretty much a normal heavy equipment drop, but you've got to be far away when it goes off," says Taylor.

Herks have flown under 60 flags, but that first job is often just the beginning of a decades-long career. Aging C-130s round out Third World air forces or join the global fleet of tramp airlifters. "Gabon had four Herks," says Gary L. Sims, a Lockheed field support engineer who helps countries care for their precious C-130s. "One military, three commercial. All four had names. People in the villages actually clapped when the planes came in. They brought family, food, animals, supplies, everything. In Niger, a mission that took a convoy of six trucks days to do could be done in one flight by the C-130, an hour and a half each way. For them it's a scheduled airline."

The C-130's payload, autonomy, and ability to live rough has won favor with relief agencies everywhere. Nowhere has it served humanity better than with the United Nations World Food Program, the largest humanitarian undertaking extant. Last year the WFP delivered food to more than 104 million people in 81 countries. Since 2001, some 275,000 tons of food has arrived by air, much of it aboard C-130s, some chartered by the UN, others contributed by such governments as Japan, Portugal, Australia, New Zealand, Venezuela, Britain, and the United States. In southern Sudan, where a combination of endless war and endless drought has created one of the great human crises of recent times, the WFP employed as many as eight C-130s. "We fly people to specific locations" to set up drop zones and markers and create an infrastructure on the ground, reports Jaco Klopper, former chief of air operations for the WFP in southern Sudan "The aircraft get sent out to drop the food." Nine tons of bagged food is attached to a pallet with webbing. "Once

the pallet goes out, it pulls a rope that frees bags from the webbing as they fall. It works quite well." Each bag has three layers. The first bursts on impact, the second may tear, but "definitely not the third one."

Klopper continues: "We fly 10 hours a day, first light to last light. We refuel the airplane as it's being reloaded. Turnaround time is about 15 to 20 minutes. If it wasn't for the C-130s, a large number of people would have died."

The airplane that the hungry or besieged or devastated listen for still rolls off the assembly line at Lockheed-Martin Aeronautical Systems' Marietta plant, where all C-130s except the two prototypes were built. At age 50, the C-130 is the military airplane with the longest continuous production run in history. (Only Raytheon's Beechcraft Bonanza has had a longer unbroken production run.) As you read this, Hercules no. 2,275—one of the new KC-130J tanker models—is emerging into the Georgia sunshine, bound for the U.S. Marine Corps. F/A-22 Raptors take shape in one quadrant of the building, but most of the space is used for the C-130 line, where 12 of the big transports are built a year.

The new C-130s look much as they always have: heavy shouldered, earnest, powerful. But the familiar exterior hides a much different airplane. The C-130J's range is 50 percent greater than the A's; gross weight has increased by 25 percent. And it is harder to shoot down, thanks to defensive sysems developed in part by Tim Nguyen, who once feared his overladen C-130A was too easy a target. As for available power, Lockheed chief pilot Bob Hill says, "If you took a guy and put him down in an A model after he'd been flying a J model, he'd think he didn't have any engines." The engines deliver nearly 30 percent more thrust than those on the H model. All told, the differences are substantial enough that Lockheed calls the J model the Super Hercules.

Internally, little remains of the airplane's 1950s heritage. The design conceived in the non-digital past has been tailored for the new century. The tiny engine gauges are gone, replaced by liquid crystal displays, as are the flight engineer and navigator. One pilot flies, the other talks to the computers.

"Everything is monitored," says Bob Hill. "The airplane tells the pilots every little thing that happens, in ascending grades of urgency. After both main computers fail, you're still better equipped to make an instrument approach than the mid-run H model. When everything's ticking right along, the GPS antenna is probably within eight feet of where it says it is."

Hill, a Marietta native who started at Lockheed in 1951, demonstrates the Super Hercules to prospective buyers, showing them, for example, how one might haul a 38,000-pound tractor from La Paz to a 4,000-foot strip in the Bolivian Amazon, or how an Indian C-130J might drop 22,000 pounds of kerosene to troops in Kashmir's mountains—after losing an engine on takeoff from a field 15,000 feet above sea level.

Already the Super Hercules seems to be everywhere. When British Prime Minister Tony Blair set foot in Basra in May 2003, it was from the ramp of a Royal Air Force C-130J. An Italian Super Herk took the exiled king of Afghanistan back to Kabul in April 2002. As for the future, there seems to be no competitor in sight. Most people believe the Hercules production line in Marietta will celebrate a diamond jubilee. Around U.S. Air Materiel Command, it's said that when they fly the last McDonnell Douglas/Boeing C-17 transport to the boneyard—the last batch of which is slated for production in 2008—the crew will fly back aboard a Hercules.

TED CARLSON/CHECK-SIX

C-130Ks destined for the Royal Air Force were ferried to Cambridge for the installation of British avionics and instruments.

SAUL McSWEEN/U.S. NAVY

Resplendent in U.S. Navy Blue Angels livery, a Marine Corps C-130T fires its jet-assisted takeoff bottles, which add 8,000 pounds of thrust for a super-short takeoff.

JOHN M. DIBBS/THE PLANE PICTURE COMPANY

Helluva Catch

Can a helicopter pilot field a spacecraft arriving from a million miles away?

by James R. Chiles

For more than two years a spacecraft called Genesis loitered in a holding pattern a million miles sunward of Earth. Its job: Pick up particles of the sun cast out by the exhalation known as the solar wind. According to planetary scientists, a sample of the solar wind far away from the Earth's magnetosphere will reveal the precise abundances of isotopic oxygen, nitrogen, helium, neon, and other constituents of the nebula that collapsed 4.6 billion years ago to form the sun and planets. Determining the precise mixture of ingredients can help explain how the solar system formed and why the compositions of its bodies differ so significantly.

Though the quantity of captured particles is tiny—the dust atop your refrigerator probably weighs more—Genesis will deliver more material than was collected on the five Apollo missions during which astronauts set up foil panels on the moon and captured nuclei from the solar wind.

Last April, its collection complete, Genesis packed up its arrays, left its post, and started for Earth. But its mission will not be accomplished until this fall, when the spacecraft's sample return capsule reenters the atmosphere, deploys a parachute, gets snagged by a helicopter, and is gingerly lowered to the ground. If the return capsule makes it and its contents are preserved intact, these will be the first samples returned from space since 1976, when the Soviet Union's Luna 24 spacecraft brought back 170 grams (six ounces) of lunar soil. They will be the first samples ever returned from beyond lunar orbit.

The advantage of sample-return missions is that the equipment necessary for analysis does not have to be miniaturized for spaceflight. "We just bring the samples back and use room-size laboratories with calibrated instruments to study the material," says Don Sevilla of the Jet Propulsion Laboratory, the lead payload recovery engineer for Genesis. That advantage is offset by the difficulty of sending a spacecraft on a round trip.

It helps to have a big backyard to land in, and that's how the Genesis team at JPL in California views the Utah Test and Training Range in northwest Utah. At more than 16,000 square miles, the range is substantially bigger than the state of Maryland. Its nearly lifeless alkali flats, barren mountains, and military-controlled skies offer one of the nation's biggest expanses for bombing, dogfighting, smoke-screen testing, strafing, and other games of war. On the morning of September 8, all such activity will halt to give Genesis and its recovery crews a clear shot.

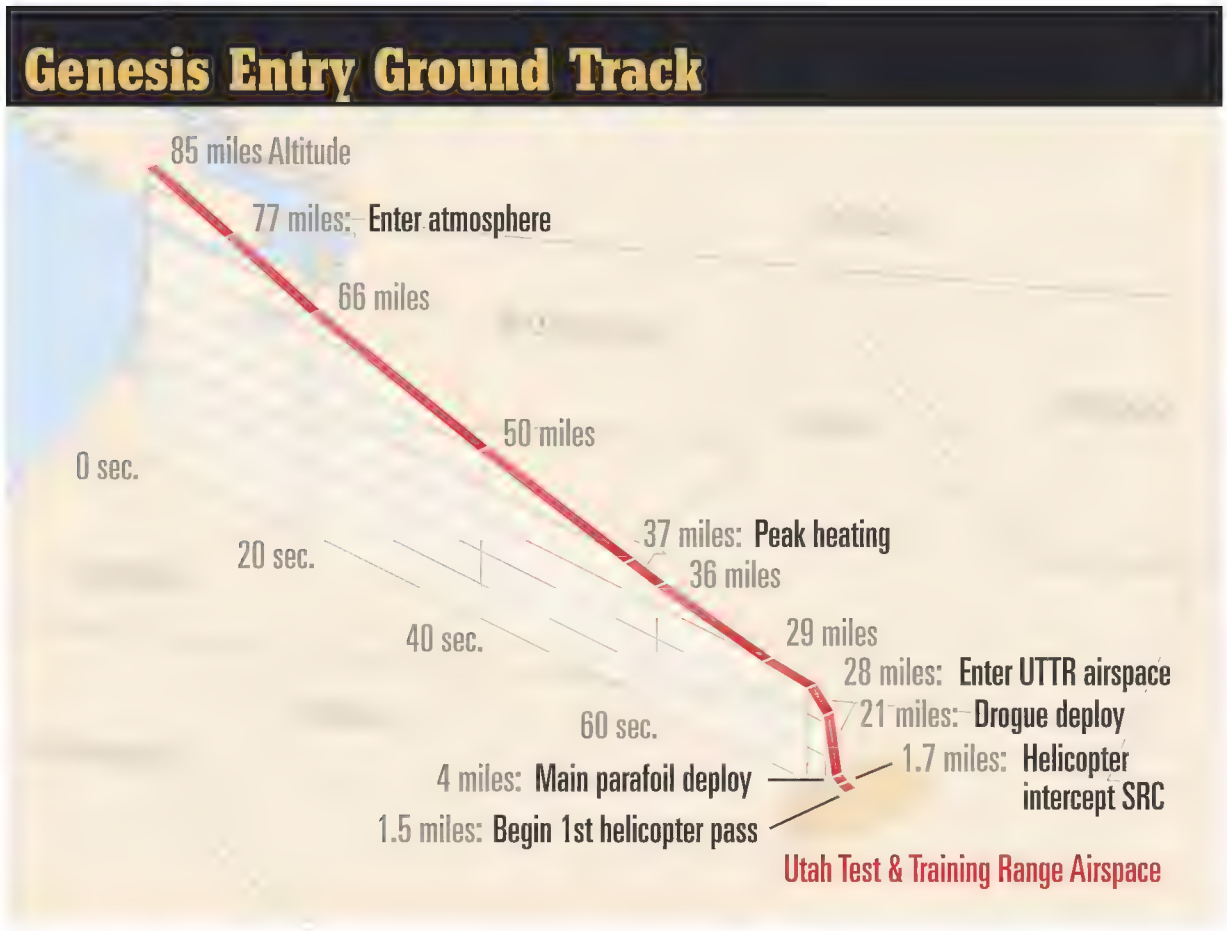
Genesis will aim for the U.S. Army's Dugway Proving Ground, an 800,000-acre tract in the southeast portion of the range. Pony Express riders of 1860, when gazing west across this area from the hills and pondering the long dry hours ahead, called this part of the Great Salt Lake Desert "the Gateway to Hell."

Even if Genesis, having traveled a million miles, pops its parachute dead center over Dugway, principal investigator Donald Burnett of the California Institute of Technology can't rest easy. If the capsule hits the ground like a paratrooper's ammunition pallet, the impact could damage fragile instruments and contaminate samples. So to ensure success for the $265 million, three-year mission, its managers have arranged a midair recovery. And they have built into the attempt what every good rocket-science experiment requires: redundancy.

Two helicopters, each flown by a high-time pilot, will be in the air awaiting the Genesis sample return capsule as it barrels back to Earth. The primary pilot is Cliff Fleming, 53, a low-key former Marine who has flown cameras for film and TV directors for almost 25 years, with 45 productions to his credit as either pilot or aerial coordinator. His backup is Dan Rudert, 45, a tall and rangy Utah-born pilot, who has a variety of missions on his résumé, including wilderness rescues, firefighting, and, like Fleming, flying for the movies. Both pilots are experienced in a kind of flying critical to the success of the mission: "longlining," or carrying heavy loads by cable. A typical longlining job involves hauling pieces of powerline towers, suspended from a hundred-foot cable, and placing them at moun-

Over Yuma, Arizona, last April, Dan Rudert in a Eurocopter AStar closed in for catching practice. The real catch will be made this fall in Utah.

NASA/JPL/YUMA PROVING GROUND



JUAN THOMASSIE; SOURCE: NASA/JPL

NASA/JPL

Top: The final seconds of a three-year mission. Above: At the Dugway Proving Ground, pilot Dan Rudert (left) confers with a team member.

tainside construction sites just as a crane operator would. To longline, a pilot must be able to control his helicopter and cargo with great precision while looking straight down—that is, without a reference to the horizon.

The Genesis recovery process is tricky enough that the helicopter crews have already trained several times over the past two years and will spend the 10 days before the spacecraft returns on more training exercises. To watch one such exercise in progress, I joined a smattering of science reporters at the Dugway main gate in late April. Once past the armed guards and barricades, we headed 30 miles west toward the training ground, deep into the barren heart of Dugway.

Tumbleweeds rolled along the highway and lodged among tufts of greasewood, juniper, and sagebrush. Beginning in World War II, Dugway's principal job was to prepare gear to defend troops and cities against biological or chemical attacks and to invent comparably hellish weapons with which to vanquish the enemy.

Asphalt pavement gave way to gravel and the road narrowed to a one-lane track, elevated a few feet over the salty mud flats. Once past the bizarrely sculpted Granite Peak, the site of top-secret World War II tests involving a British anthrax-filled projectile, our caravan stopped and reporters spilled out into the cold. As we waited, Don Sevilla began an impromptu lecture about the spacecraft.

Sevilla pulled out a hand-size sample of one of the capsule's five solar-wind collectors. It had the blue sheen of a solar cell. On board Genesis, such panels consist of 55 hexagonal tiles coated with a variety of atom-catching films, made of silicon, germanium, or precious materials such as gold, sapphire, and diamond. Each of the five arrays, about the size of a bicycle wheel, was packed off into space ultra-clean and burnished to near-perfection.

NASA/JPL

Genesis made its own catch with arrays of ultrapure, ultrathin films.

They won't come back that way. "The silicon [especially] was fragile when it was launched, and now it's more so," Sevilla said. "Some have been hit by micrometeoroids. The estimate is that two [tiles] per array have a hole blown right through them." Sevilla is hoping for a delicate touchdown, the principal reason for the practice now getting under way overhead.

A test payload, an orange concrete-filled cylinder, had been dropped from 15,000 feet and was on its way down in a lazy spiral, under a parafoil. Parafoils are giant airfoils that can be directed in a glide to Earth, instead of falling in the manner of conventional round parachutes.

The payload was taking its time in breaking out of the thick cloud layer, and in the meantime, range safety official Bryce Billings asked for our attention. "If the helicopter misses it, it'll come on down and if the wind shifts it could land right here, and it weighs 405 pounds, so be ready to evacuate," he said. I pictured reporters and photographers scattering across the salt flats where, we had been warned before entering, unexploded and uncounted warheads from Dugway's dark past might be waiting.

But there would be no fumbling of this concrete-filled football. A three-man recovery crew in a blue and silver Eurocopter AStar helicopter was primed a half-mile up to make the catch: pilot Dan Rudert, director of flight operations Roy Haggard, and payload master Lynn Fogleman. The helicopter's radio call sign this day, "Vertigo 1," is the name of the aeronautical engineering company that employs Haggard and Fogleman. Nearby a backup

crew in a Bell 206 waited to assist.

Even though Rudert would intercept his target by first skimming just three to seven feet above the payload canopy, he used no special instruments during the approach. The red, yellow, and green parafoil offered sufficient reference points as Rudert took up a formation above and behind, and angled in for the catch. The pilot later likened the interception to his work for the movies: "Lots of times we have a camera affixed and we're doing precision flying. We have to fly low and close to a car, say. It's similar to how we approach and catch a parafoil here."

Trailing from the helicopter was an 18-foot pole. As Rudert swooped past his quarry, events followed in quick succession: A black metal hook on the pole grasped the rear edge of the parafoil; the hook popped off the pole, taking with it a high-strength, aramid-fiber line that spooled from a winch in the helicopter; and the hooked parachute came to an obedient halt 60 feet beneath the AStar, where the winch's increasing tension stopped it. Simultaneously Rudert had pulled the Astar into a climb and bled off forward airspeed. "We have to limit that airspeed to 10 to 12 knots," Cliff Fleming explained later, "or the parafoil could re-inflate."

As Rudert made the catch, the backup crew began searching for the closest suitable spot to land and spread out a tarp to serve as a target for Rudert. Calling on his longlining experience, Rudert gradually descended, ever so carefully. It took several minutes before he settled the simulated payload onto the tarp. Technicians removed the parafoil and rigged the payload directly to the helicopter's cargo line. This step—removing the parafoil—will allow the helicopter to fly the payload at cruise speed to Dugway's airport.

An hour later, Rudert's helicopter was back in its hangar at the airfield and available for press inspection. Besides the folded catch pole, the most obvious modification to the AStar was a big winch bolted to an aluminum pallet, which took up half the rear compartment. The 50-year-old winch is a piece of aerospace history, according to Bob Veazey, a midair-recovery expert who is assisting Vertigo. Its manufacturer, All-American Engineering, provided such gear to the Army during World War II to scoop up downed fliers and secret agents from behind enemy lines. It worked so well that eventually C-47s were able to snatch big troop-carrying gliders off the ground. The company was following in the footsteps of earlier on-the-fly projects: In 1939 pilots in light airplanes like the Stinson Reliant grabbed mailbags from towns with no landing strip. All-American also made the recovery gear that U.S. aircraft used in the 1960s to catch film dropped from Corona spy satellites.

Back at the practice area, JPL's Don Sevilla compared the pole, hook, and winch aboard Rudert's helicopter to oversized fishing tackle: "It's just like catching a fish, but this fish doesn't fight back." Rudert and Fleming know, however, that a deployed parafoil attached to a helicopter can fight back...and win. It could rise like a kite behind the helicopter and drag its nylon lines against the tail rotor. If the parafoil were to threaten the helicopter, Fogleman has a pyrotechnic rope-cutter he can use to cut parafoil and payload loose. Such a cutaway was necessary on an earlier training mission.

Even with a so-far-healthy spacecraft and a midair recovery technique refined over 60,000 missions since the beginning of World War II, enough uncertainties remain with Genesis to scoot the mission planners toward the edge of their chairs as September approaches. Beginning in August, the spacecraft will execute three small rocket burns to fine-tune its beeline to northwest Utah. If it makes it, Genesis will be the first one home of NASA's three sample-return missions. CONTOUR, which was to have returned comet dust, was lost in August 2003. Stardust, which has already collected dust from a comet, is expected to descend into Utah in 2006. The missions were the response to NASA's Discovery program challenge, says Don Sevilla. Scientists had to figure out how to perform significant, analytical science with lightweight, low-mass, and therefore low-cost spacecraft: The answer is to leave the laboratory back on Earth.

D.C. AGLE/JPL

In Utah, the fake capsule is loaded on a pickup. Below: The peanut gallery wonders: "Did he get it?"

NASA/JPL

At these model airplane rallies, the smell of jet fuel is in the air.

TINY TURBINES

by Ed Regis

Photographs by Erik Lunsford

Amid the high whine of turbines spooling up, the booming rumble of hot exhaust gases, surges of jet blast kicking up waves of sand and grass, and the sharp smell of jet fuel, a Grumman F9F-5 Panther is in the initial stages of startup. Wearing regulation Navy blue and sporting a sliding canopy and tip tanks, it is a glossy, beautiful machine, one of the best-looking on the ramp. Stenciled below the canopy is "Comdr. Lewis Patton Jr." However, Commander Patton will not be in the cockpit, which is occupied by a pilot figurine. He will be flying the Panther from the ground at this gathering of radio-controlled jet models and their pilots.

It's a fine Friday morning in early October, day five of Superman Jet Week at Metropolis Municipal Airport in southern Illinois. Scale-model jets have been streaking past the show tents at 200 mph and performing extreme, seemingly impossible, and otherwise deranged maneuvers since shortly after sunrise. Most of these are big machines, some almost eight feet long, with wingspans of seven feet or more. Patton's craft (84 inches in both length and span, 34 inches tall with gear extended, and 50 pounds in gross weight) will be joining them aloft as soon as he starts the engine, a procedure that, although the specifics differ slightly, takes about the same time as is needed for a full-size jet. "About 30 seconds," Patton says. "Introduce air, propane, then back up to air, and then it spools up to idle rpm, and once the temperature's okay, then you're ready to go." He uses propane first because it ignites more readily than Jet A fuel, a type of kerosene, which he'll switch over to at idle speed—a mere 40,000 revolutions per minute. "Max rpm is 115,500," he says.

Patton is monitoring the engine's performance with a clutch of instruments in a red Radio Flyer wagon. Slung underneath the wagon is an air tank used to spin up the turbine; in the wagon is a propane tank, assorted wires and tubing, a frequency scanner, an engine data terminal with digital readout, a programmer, and myriad meters, dials, quivering needles, flashing lights, buttons, and switches.

Soon the engine is emitting a fine roar and the Panther trembles with barely suppressed intensity. The turbine is now feeding from two portable tanks of Jet A, one atop each wing. At max thrust, the tiny turbine en-

Radio-controlled model jets and their pilots, scale and full-size, line up for Superman Jet Week.

gines burn 12 to 16 ounces of fuel or more per minute—at least a beer bottle's worth—and the internal fuel cells are so small—22 ounces each (although a given craft may hold two or three)—that the engines must draw from external tanks until just before takeoff.

Finally, Patton's assistant, Keith Yates, who wears a blue cap bearing the Superman "S" logo, switches to internal tanks, and Patton gathers up his cigar-box-size radio transmitter, which has dual joysticks, six toggle switches, and an LCD screen. Walking behind the Panther, he taxies out for takeoff.

Runway 36-18 is a standard 4,000-foot length of black asphalt. The model takes its position on a yellow stripe, the engine spools up to an earsplitting shriek, and the F9F blasts straight down the centerline. It's off the ground, as if shot by a catapult, in seven seconds.

Though Patton, a retired middle-school band leader from Louisville, Kentucky, has sunk $11,000 in this machine, he does not baby it around the pattern. "He's up there doing slow rolls on top of a perfectly vertical climb," the announcer says. (Perfectly vertical climbs are pretty much the only type of climbs here.) This is followed by a vertical dive (ditto), then a thundering low pass down the runway, followed by a vertical pullup embellished with two snap rolls. At about 200 feet, the airplane goes over on its back, drops through a two-turn inverted spin, recovers… After about six minutes of further gyrations the Panther is low on fuel, so Patton powers back, transitions to slow flight, lowers the landing gear, and, while another model lands, makes a "gear pass" down the runway to check if all three struts are fully extended. Satisfied, he makes a slow climbing turn to downwind, then sets up an approach. With full flaps and gear intensifying drag, the airplane's glide path resembles at best a controlled plunge, but at the last moment it levels off and Patton paints the thing on so smoothly you'd swear he was in the cockpit. When he applies the brakes, you can hear the tires squeal.

The Primordial Model Jet Engine

The Superman jet rally kicked off in 1988, when Jerry Caudle, a pilot who also happened to be manager of the Metropolis Airport and a modeler himself, put on a flying competition for radio-controlled jets. At that time, most jet models were powered by ducted fans, miniature piston engines driving seven-blade propellers inside ducts.

The rally drew 45 pilots. Ten years later, the Superman rally was regularly pulling in 200-plus enthusiasts from 30 states and a dozen countries. Last year's event brought pilots and airplanes from Hawaii, England, Argentina, Venezuela, Germany, Finland, and Japan. Even Caudle, however, has trouble accounting for the rally's hold over jet modelers. There are major radio-control jet events annually in Lakeland, Bunnell, and Lake Wales, Florida; Tucson, Arizona; Chino, California; and Whidbey Island, Washington, with regional contests held all around the country. "This is more or less a fun fly, where everybody gets to fly as much as they want," Caudle says. "It's just an annual event that in the last two or three years has been the largest event of its kind in the world."

Location seems to have played no role in attracting an international crowd to Metropolis (population 6,700), which, being a 180-mile drive from St. Louis and the closest major airport, is equally hard to get to from everywhere. The city itself has a down-at-the-heels look, I tell him. "This city?" Caudle says, affronted. "It's got a riverboat. They just paved every street and alley in town. It's got all new sewers."

Even with its magnificent sewers, however, this is a town of no particular charm, consisting mainly of used-car lots, video stores, tire outlets, bar-

In the 1950s and '60s, the Dyna-Jet Red-Head pulse-jet engine was the hot ticket in control-line model airplane circles. Based on the same operating principles as the engine that powered the German V-1 buzz bombs of World War II, it produced self-sustaining resonant shock waves. A mix of lantern fuel and air was ignited in a combustion chamber, and the resulting explosion would force a spring-steel valve (the sole moving part) behind it to slam shut. As the blast exited the exhaust tube, a wave of low pressure rippled back toward the chamber, sucked open the valve, and drew in another charge of fuel and air. The mixture, ignited by the heat remaining in a spark plug, repeated the cycle until fuel was exhausted.

Whether one mounted it on a hardwood stick fuselage with tiny wings and went for straight speed (Dale Kirn set the first Academy of Model Aeronautics record for jet speed, 154.98 mph, with a Dyna-Jet in 1954) or encased it in a model F-86 or MiG-15, producing a Dyna-Jet-powered model at the local flying site drew a crowd faster than a bag of free money.

Everything about the Dyna-Jet was abrupt. It was either completely off or way-the-hell on. It took a ground crew and a certain finesse to evoke just the right conditions for the pulsing explosion cycle to become self-sustaining. An old Ford ignition coil fired a spark into the combustion chamber while a bicycle pump ushered a blast of air and white gas through the intake nozzle; the latter more often than not would just drizzle out the tailpipe. It was usually easier to set the grass on fire than to get the Dyna-Jet lit. Once a few loud burps got the combustion chamber hot enough to ignite the next charge, one lucky start attempt would result in a sudden and devastatingly loud roar, and the model would strain in the holder's hands while the pit crew attempted to maintain their wits long enough to disconnect the starting apparatus and clear the launch area. The previously curious cluster of spectators would scatter for cover. Just getting a Dyna-Jet-powered model airborne was its own pinnacle of achievement—unlike stunt, combat, or any of the other categories that require actual flying.

HARRY WHITVER

When the pilot gave the signal for release, the model would lunge forward and roar around a circle defined by the control lines until velocity overcame the high wing-loading (the amount of weight the wing had to lift). In due course the craft would climb to cruise altitude (shoulder height). For the next few minutes, there was little for the pilot to do but hang on, hope the control system did not come apart, and wait for the fuel to run out. The series of gasoline explosions caused 250 individual pulses to cascade out the tailpipe every second, creating a Doppler-shifted wail of indescribable proportions while the hapless model was flung by its gigantic blowtorch, constrained by two improbably slender control wires and the grim determination of the pilot.

About the time spectators began to creep closer, the concussive roar would abruptly cease. The model would then best be flown onto the ground as quickly as possible. In the silence that ensued, all present would absorb the event and then store it in the little alcove of memory reserved for Truly Remarkable Incidents.

—Larry Lowe

Clockwise from above left: A basic radio transmitter may have four channels, but modelers can add more for flaps, retractable landing gear, spoilers, starting the turbine engine, and dropping bombs. Bob Violett, a legend among jet modelers, tinkers with his F-80 Shooting Star. Violett-designed, a Model KingCat is guided to a picture-perfect touchdown. Used KingCats start at $13,000 (engine included). Kevin McLeod picks up the pieces after a midair collision.

gain huts, gas stations, and closed businesses. On the other hand, there is the Superman effect.

In the early 1970s, resident Robert Westerfield, mindful that the legendary Man of Steel hailed from a fictional Metropolis, saw a golden opportunity: Why not officially declare the city the Hometown of Superman? Unconcerned that Superman was born on the planet Krypton and raised in Smallville, Kansas, the Illinois House did exactly that in 1972. Metropolis now boasts a Superman Car Wash, a Superman Museum, and a 15-foot bronze Superman statue smack in front of the Massac County Courthouse.

What all this has to do with the success of Superman Jet Week is debatable, for the only thing Superman and the scale-model jet fliers seem to have in common is an inordinate love of speed. "My husband's Bandit easily does over 200 miles an hour. My BobCat will only do about 175 or so," says Dawn Ellzey, a travel agent from Grand Prairie, Texas, and a modeler who also holds a multi-engine rating in full-scale airplanes. "The speed is a definite factor for the turbines."

"That one is capable of 300 miles an hour," says Patton of another of his models, a Predator 175. "But we're reg-

ulated by the AMA [Academy of Model Aeronautics] to 200, so I'll be flying half-throttle most of the flight."

All this velocity is a function of the turbine engine, which is often the most expensive component of a model jet. Modelers generally build their own aircraft from scratch or kits, which range all over the map in price, materials, and amount of assembly required. A basic "sport" model is a conglomeration of balsa wood, fiberglass, and carbon-fiber composite materials that costs from $2,000 to $8,000 or more.

The turbines that power them are mechanically complex, technically demanding, and electronics-heavy precision instruments. The P200, a state-of-the-art JetCat engine made in Germany, is five inches in diameter, weighs less than five pounds, and, at a max rpm of 112,000 and exhaust gas temperature of 1,240 degrees Fahrenheit, gulps 23 ounces of fuel per minute to produce 50 pounds of thrust. Total cost, including accessories: $4,995.00. Put one of these in a model aircraft and everything starts to happen fast—sometimes too fast.

Early in the afternoon Mike Fuller is flying an Aermacchi MB339, a specialty sport model built by Jack Mathias. (It is not unusual for builders to have someone else do the flying.) Both live in Evansville, Indiana, and have driven here in a camper. With the airplane on final approach, Fuller senses that it's handling a bit strangely and suddenly realizes he has forgotten to lower the flaps.

When he does, the airplane pitches down and before he knows it, makes what might politely be called abrupt contact with the runway. It bounces, which bends the nose gear (though Fuller does not realize this at the time), then slews into the grass but keeps streaking along. In order to finish with a proper approach and landing, Fuller firewalls the throttle for a go-around. The model shrieks back into the air but on the downwind leg it slows, staggers, and crashes in a bean field along the runway.

"I just lost airspeed," Fuller tells Mathias later. "When I made that turn and started downwind, all of a sudden it slowed down and I said 'We're in trouble, we're in trouble.' I was just trying to coast it and get a rudder turn and get in, and it never picked up speed."

"But you don't think the engine quit," says Mathias.

"Yeah, I do," says Fuller. "There's no way that that engine shouldn't have powered me out."

"God, that was ugly!" Fuller adds. "What is your saying, Jack? 'Run out of airspeed…'?"

"You run out of airspeed, altitude, and ideas, all at the same time. That's what causes accidents." Much laughter.

Later, Mathias sent the engine back to the manufacturer, SWB Turbines of Neenah, Wisconsin, where technicians found the combustion chamber clogged with grass clippings but otherwise undamaged.

Earlier that day, Dave "Stick" Valdez, who drove a van from his home in Orlando, Florida, was admiring his fiberglass BVM Maverick Pro as it performed a split-S, a maneuver he'd done at least a hundred times. Five other aircraft were aloft simultaneously, including a balsa model flown by Kevin McLeod, a Canadian from Burlington, Ontario. Both pilots had their eyes glued to their aircraft, Valdez watching his come straight down from the top of a loop, McLeod monitoring his as it turned from crosswind to upwind, when suddenly both saw that the two models had merged. Fragments fluttered into the nearby acreage, whereupon Jerry Caudle trundled off in his golf cart to pick up the pieces.

"It happens," Valdez says later. "It's nobody's fault. You can do whatever you want here, as long as you maintain that oval pattern. And we were both doing it."

"This was my third flight of the day," McLeod says. "And everything was going real good until…I speared him from behind.

"The engine's come out quite well," he adds, eyeing his SimJet 1200 turbine as it cooled on the ground. "I haven't run it up yet. It looks like it might have ingested a little bit of dirt, but there's no damage to the compressor blade and it spins over smoothly, so that's usually a good sign."

Indeed, a little FOD (foreign object damage) is nothing insurmountable here, not with the presence of the Repair Technology International trailer and turbine mechanic Carlos Villarreal. Based in Miami, Villarreal travels from one jet rally to another with his mobile repair shop, in which he can rectify practically any engine failure short of a major burnup in just a few hours.

Satisfies the need for speed: Some models can do 300 mph.

"I have a balancing machine in the trailer, I've got a lathe, I've got all kinds of welding equipment—everything I need." His workbench is covered with what seems like hundreds of wrenches, screwdrivers, drills, pliers, torches, and so on, all neatly stowed in their allotted spots. He has an endless supply of ceramic ball bearings, bearing housings, combustion chambers, turbine wheels, compressor wheels, glow plugs—the works. Jet engine repairs are not cheap—a simple bearing change, the most common fix, is $295—but at least you're flying again.

Spend some time on the rally grounds and you realize that the emblem of BVM Jets is omnipresent. The trademark appears on hats, jackets, T-shirts,

coolers, and the wings and fuselages of the models. BVM stands for Bob Violett Models, a top manufacturer of radio-controlled jets. "Probably 40 percent of the aircraft out here are Bob Violett's kits," says Vernon Montgomery, a modeler from Mississippi who is flying a BVM F-4 Phantom II.

Violett flew the Douglas A-4 Skyhawk during the Vietnam War. "I flew a combat tour over North Vietnam," he says. "I got shot at a lot, dropped a lot of bombs and rockets and missiles—flew 83 missions off the USS *Hancock*." He flew the Vought F8U Crusader with the reserves, and in peacetime, he flew Lockheed Electras and Boeing 727s for Eastern Air Lines for 18 years.

"I started off as a modeler very early in life," Violett says. "They say I taught myself to read to be able to build models around five years old—that's how the story goes." In the early 1980s he started building models and selling them out of his garage. Today he runs a factory in Winter Springs, Florida, oversees 20 employees, and keeps expanding the technical boundaries of turbine-powered model aircraft.

Violett's star product is a scale F-100F Super Sabre, which, in pictures at least, is indistinguishable from the real thing. And, Violett says, it flies even better. "We use gyro augmentation on these jets, on the vertical axis and the rudder," he says. "As in all swept-wing airplanes, they have something innate: Dutch roll. Anytime the airplane is upset, one wing is always advanced in angle of attack, so it'll pitch up a little bit, and that causes more drag, and so it starts an oscillation." The airplane ends up wagging its tail from side to side like a happy dog. To dampen the oscillations, Violett and his engineers attached piezoelectric gyros to the rudder, devices that sense Dutch roll and cancel it through slight rudder movements.

"They make you look like a much better, smoother pilot," Violett says of the gyros. "They take all the wiggle out of the airplane." The resulting stability is much in evidence when Violett maneuvers his Super Sabre through a flawless four-point roll, a maneuver that, because of its difficulty, is rare among jet modelers.

At 5 p.m., free beer and pizza are served in a tent near the food stand where, earlier in the day, $3 elk burgers were sold. One of the last to fly is Gary Jefferson, a packaging materials salesman from Monroe, Ohio. He wants to get in just a couple of more flights before he has to quit for the evening.

It's getting cold and overcast now, not to mention gusty, and Jefferson's wife, Sandy, has pulled on a coat, though it doesn't seem to help much. Even the family dog is wearing a red blanket.

Jefferson, undaunted, blasts his Fiber-Classics Rookie around the pattern and goes through the customary show of wild aerobatics until he can barely tell which side of the model is up. "See, you can still tell the fin's on top," he says, squinting into the gloom. Finally it's too dark even for him. He makes one last, perfect landing. The engine spools down. Time for a beer.

Though all that is visible of the figurines are heads and shoulders (left), they are faithfully detailed down to the boots. At $50, they're a cheap date (somebody call Barbie). During Superman Jet Week (below), Metropolis Airport is closed to full-size airplanes while model jets take over the runway.

Special Report

Turn Off That Phone!

by John Croft

Why you can't use your electronic gadgets aboard airliners.

The frequency of radio waves emanating from mobile phones and airliner avionics is measured in megahertz. The power of a radio signal is measured in decibels relative to milliwatts, with zero dBm equalling one milliwatt. The graph below shows that while the mobile phone broadcasts its intended signal at 1,850 megahertz, it also puts out a low-power buzz over a range of frequencies. Lines beneath the chart indicate possible interference from both types of signals, since aeronautical transmitters broadcast at the same frequencies.

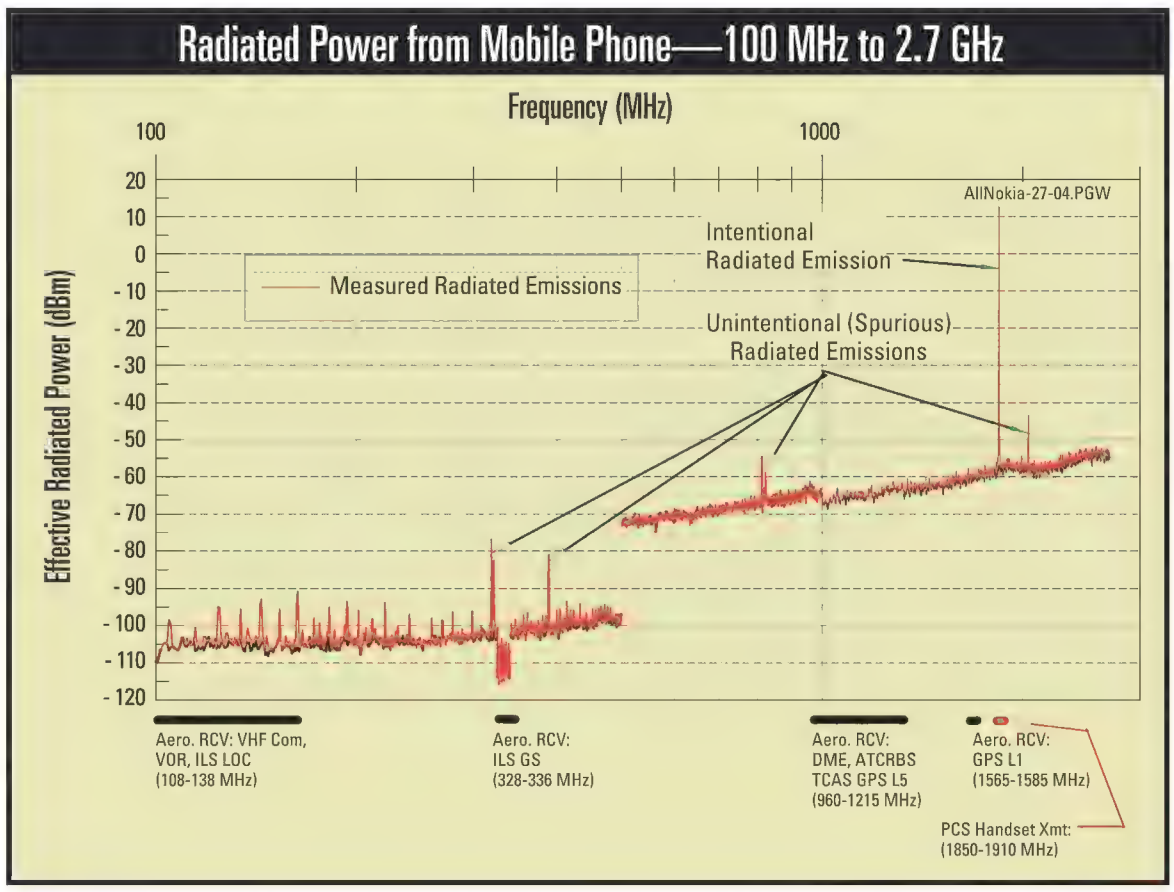
Soon after Frontier Airlines flight 469 departed Baltimore for Denver on the night of December 2, 2003, passengers in the Airbus A319 twin-jet doled out $5 each to rent headsets for the carrier's television service. The woman in seat 14E, however, had a cheaper alternative: She powered up a hand-held TV set.

Bad move. A flight attendant swooped in and told her to turn it off. Portable TVs are taboo on Frontier airplanes, one of the details illustrated in the laminated safety brochure that no one seems to read. After the attendant moved away, 14E turned her TV back on, only this time she hid the portable's blue glow under an airline pillow.

Turning on a portable TV inflight seems innocent enough. The airlines offer their own television and phone service, so why should using a portable version of either be a problem? The truth is that portable electronic devices, such as mobile phones, compact disc players, and remote-controlled toys, can emit powerful electromagnetic radiation that can muck up an aircraft's navigation and communication systems and actually endanger a flight. Airline telephones, on the other hand, transmit radio signals to and from antennas mounted externally on the aircraft, and such phones meet Federal Aviation Administration specifications that prevent them from interfering with the aircraft's radio and navigation systems. Portable electronic devices do not currently meet such FAA requirements.

Although 14E's disobedience, duly noted by a passenger across the aisle—me—did not appear to affect how the aircraft handled, such apparently innocent diversions have caused problems on other flights. The captain of a Boeing 737 airliner on an instrument approach to Baltimore-Washington International Airport one night in March 2003 reported that his course indicator, called a localizer, had been centered during the approach, then suddenly showed a full deflection. Just then the aircraft, flying on autopilot, broke out of the clouds—at an altitude of 2,500 feet and a full mile off course. The incident is described in NASA's Aviation Safety Reporting System (*asrs.arc.nasa.gov*), a service that allows people to anonymously report aviation problems.

The 737 pilot theorized that after announcing that the United States had started attacking Iraq (information he had received from air traffic control), one or more passengers had placed



NASA LANGLEY

CHAD SLATTERY

The truth is that portable electronic devices can emit powerful electromagnetic radiation that can muck up an aircraft's navigation and communication systems and actually endanger a flight.

calls on their mobile phones. His suggestion for prevention: Never make an announcement to passengers that might encourage mobile phone use during a flight.

Bruce Donham, who has spent a decade studying such interference for Boeing, recalls several incidents when the manufacturer was informed of anomalies—like an autopilot turning itself off during cruise or an airplane banking on its own—and advised the airlines to purchase the suspect portable electronic devices for tests. To the frustration of Boeing engineers, follow-up testing never duplicated the problems, either on subsequent flights or in the lab. "We think it's a very low risk," Donham says of the threat from electronic devices, "but we have to gather data to prove it out."

The government first began investigating disruptions from carry-on devices in the early 1960s, when an FM radio was blamed for an incorrect off-course indication. The U.S. Radio Technical Commission for Aeronautics (RTCA), an FAA advisory group, called together government, industry, and academic experts to investigate the problem. Decades later, RTCA continues to study the threat: Its 1996 findings and associated advisory circulars published by the FAA form the basis for airlines' ground rules on portable electronic devices in the air.

The advice calls for some electronic devices to be turned off whenever an aircraft is below 10,000 feet to "lessen the possibility of interference" during takeoff and landing, and encourages carriers to explain to the public the reasons for the prohibition. For mobile phones, the FAA defers to Federal Communications Commission rules, which prohibit their use when airborne. Though interference with aircraft is a potential problem, especially with mobile phones that boost their power output when searching for service, the FCC's concern is that a mobile phone roaming at 35,000 feet will contact multiple towers at the same time, causing disruptions for ground-based users. Aside from mobile phones, the FAA leaves the ultimate decision on what can and can't be used to the carrier and the pilot.

Frontier Airlines' safety cards give passengers pictures of the dos and don'ts, but not explanations. Passengers are forbidden to use radios, radio-controlled toys, and TVs—ever. (Because they're tunable over a range of frequencies, TVs and radios could be especially troublesome.) Laptop computers, mobile phones, video games, and CD players may be used when the flight crew says so.

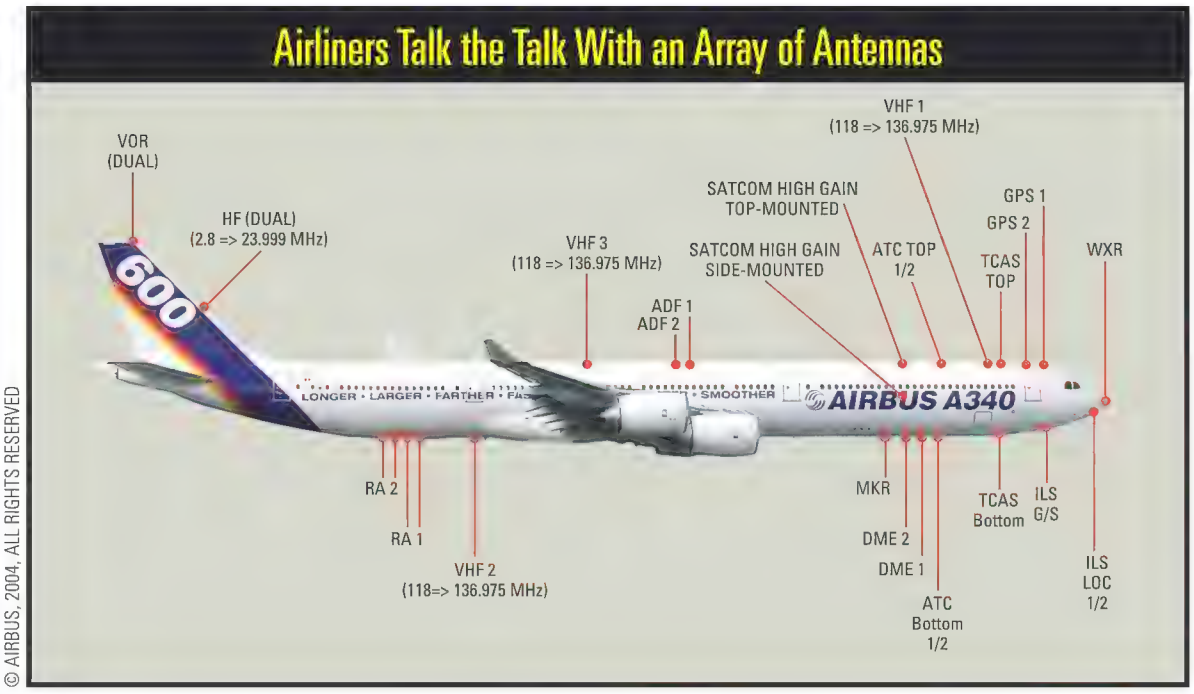
The fact that more than four decades of study has not cleared up the uncertainty that remains is testament to the complexity of the issue. The basic science, however, is irrefutable: An aircraft's flight navigation and communication systems receive radio signals from ground stations and orbiting satellites through antennas mounted on the aircraft's exterior. Electronic boxes at various locations inside the aircraft process the signals gathered by the antennas to provide information for cockpit displays, and cables running throughout the aircraft route communications between the antennas, boxes, and cockpit displays. Portable electronic devices can corrupt these avionics networks in two ways. If a passenger talks on a mobile phone or watches a TV inside the aircraft, radio waves emitted from these devices can flow through aircraft windows and leak past door seals. Engineers refer to this as "front door" interference because once outside the aircraft, the radio emissions can be picked up by the craft's antennas, which then are less able to pick up and send transmissions to and from, say, an air traffic control tower on the ground or an orbiting navigation satellite. And, though less likely, the same emissions from an onboard mobile phone or TV set can mingle with signals passing through cables running under the floor and in the airframe shell; they can even radiate directly into the aircraft's electronic boxes. Both are examples of "back door" interference.

For front-door interference to occur, however, there must be overlaps between the frequency and power of two radio transmissions. A popular mobile phone, for example, broadcasts its intended signal at a frequency of 1,850 to 1,910 megahertz and a power level of 30 milliwatts. At the same time the phone is emitting its intended broad-

cast loud and clear, it is also putting out an unintended, or spurious, low-power background buzz of radio signals ranging in frequency from 100 to 2,000 megahertz. It just so happens that the very high frequency radio that air traffic control uses to communicate with cockpit crews broadcasts at frequencies of 118 to 137 megahertz, which falls within the frequency range of the mobile phone's background buzz. Interference is not likely to occur, however, as long as the VHF transmission is sufficiently stronger than the phone's background buzz. But the farther the airplane flies from an air traffic control tower, the weaker the tower's signal is when it reaches the airliner. And if the phone transmits a signal that has the same frequency as the tower's and is nearly as powerful, the two signals will compete with each other. Result: interference.

That's one way to explain what happened to Richard Innes, a pilot who flies McDonnell Douglas MD-88s for a major airline. A year and a half ago, Innes was in cruise flight near Indianapolis, Indiana, when static over his headphones made it difficult to speak with his copilot. "It wasn't hair-raising—more like annoying," he says. Innes then made what's known as a "PED announcement" to the cabin, asking passengers to turn off all portable electronic devices. The problem cleared up and Innes was inclined to leave it at that. "I'm not sure what people were operating in the cabin," he says. "When you're up in the cockpit, your main focus is flying. You don't have time to play flight test engineer."

It's likely, though, that flight crews will continue to experience PED intrusions as airline passengers seek the convenience of electronics while in transit. However, some companies are developing technology to allow passengers to safely use cell phones during flight. Arinc/Telenor has designed a system to enable cell phone base stations on the ground to communicate with airborne cell phones via a device installed on each airliner. During critical phases of flight (takeoff, approach, and landing), the cell phones would be remotely disabled, and at 30,000 feet and above the phones would be turned on, transmitting at power levels that wouldn't interfere with airline avionics. Arinc/Telenor expects to have a proof-of-concept demonstrator available later this year, after which testing and certification could begin. It could be a long time, though, before the Arinc/Telenor technology finds its way onto FAA-certified aircraft.



Modern airliners bristle with antennas, which allow the flight crew to talk with air traffic control and enable instrument landings, avoidance of other aircraft, and communication with navigation satellites.

When it comes to electromagnetic phenomena, proving cause and effect is difficult because an unknown number of factors have to be considered, not the least of which is how many people and seats the electronic device's signal had to pass through before it went through the "front" or "back" door (what engineers refer to as path loss) and whether external sources, such as lightning, ground-based military radars, and television and radio stations have contributed.

The RTCA committee is looking into onboard solutions for protecting avionics: installing window and door shielding that would prevent portable electronic device signals from reaching external antennas, getting manufacturers to build mobile phones and other carry-on devices that won't interfere with aircraft electronics, and evaluating interference detection systems for the crew. Jay Ely, an RTCA committee member and electromagnetic interference researcher at NASA's Langley Research Center in Virginia, says the current detector systems have problems involving the handling of false alarms.

There's much discussion within the industry as to whether the guidelines in place are too strict or too liberal. Ely and his counterparts are of the opinion that more restrictions may be needed. During several weeks of tests on a Boeing 747 and a 737 in 2002, NASA found that an ultra-wideband transmitter operating within FCC limits in a passenger cabin could wipe out depictions of nearby aircraft on a pilot's collision avoidance system screen, as well as cause "erratic motion and failure" of the instrument landing system's horizontal and vertical course guidance indicators, among other unwanted effects.

As for Frontier Flight 469, the pilot's pre-landing pep talk—"Ah, folks? We're about to begin our approach. Seat backs up, tray tables stowed, and all portable electronic devices off"—made at least one passenger—me—feel safer, since it got 14E to switch the TV off and put it away. Though the "why" may have been unclear, the authoritative baritone from the front office was not.

Smithsonian
National Air and Space Museum

— Jon Reynolds, Brigadier General, USAF (Ret.) in front of one of his favorite planes in the Smithsonian collection, the F-100D Super Sabre. The aircraft is presently kept at the Paul E. Garber Preservation, Restoration, and Storage Facility in Suitland, Maryland.

PHOTO: ERIC LONG

"All these aircraft set every milestone in aerospace history..."

"Thirty-one years in the Air Force gave me many great opportunities. I flew several memorable aircraft including the F-100, the F-105, and even a MiG-17 when I was stationed in China as Defense Attaché."

His first opportunity was at age 12, when Jon Reynolds flew in a float plane off a lake in Canada. Hooked on flying, he went on to an extraordinary career. He's a pilot with two combat tours in Vietnam, a retired Air Force Brigadier General, a professor with a Ph.D. in history who taught at the Air Force Academy, and a Board member of the National Air and Space Museum.

Jon Reynolds and his wife, Emilee, have also taken the opportunity to make the National Air and Space Museum beneficiary of a generous trust. They are now members of the *Smithsonian Legacy Society*.

Find out how you can include the National Air and Space Museum in your estate plans. Fill out and return the reply form below, or call 202-633-2602. You may also e-mail legacy@nasm.si.edu. Additional information can be found at **www.nasm.gift-planning.org**. Continue the opportunity for everyone!

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A&S 09-04

THE RISE AND FALL AND RISE OF IRIDIUM

IRIDIUM HAD EVERYTHING IT NEEDED TO BECOME AN AEROSPACE GIANT—EXCEPT CUSTOMERS.

by Craig Mellow

Illustrations by David Povilaitis

IT WAS 11:30 on a Friday night in 2003 when Mark Adams got a call at his home in suburban Virginia. The Alaska Rescue Coordination Center was on the line, looking for a pilot missing in the vast northern forests of the state. The flier had been carrying a telephone serviced by Iridium, a global satellite network for whom Adams is the chief technical officer. In 2000 Iridium had come within a whisker of disappearing itself, but it lived to transmit again, thanks to the magic of Chapter 11 bankruptcy.

The Alaskan pilot wasn't so lucky. Iridium has staff on duty 24-7 to support the technical operations of the system, and though Adams spent several hours that night coordinating an effort to identify the approximate location of the flier's last transmission, by the time rangers found the man, he was dead. Since that Friday night call (which Adams got because a friend associated with the Alaska Rescue Coordination Center just happened to remember that he worked at Iridium), Adams, 40, has aided in a dozen successful rescues, most memorably one of a pilot with engine trouble off South America's Cape Horn. Thanks to Iridium, the pilot arranged an emergency landing on a snow-covered speck of an island in the far south Atlantic. The derring-do is a small part of the chief technologist's work. But for Adams, an MIT research engineer with a Bill Gates anti-haircut who when asked to give a visitor driving directions goes to a white board, it symbolizes the lurch his life took four years ago toward adventure and the outer envelope of information science.

The unlikely path Adams' life has taken resulted from a few folks taking a second look at the greatest dog ever launched into space and having the chutzpah to offer its receivers half a cent on the dollar. And from knowing enough people in the Pentagon who were bent on keeping Iridium as a unique battlefield resource, the worth of which has been proved daily for U.S. troops stationed in Iraq and Afghanistan.

Surely you remember Iridium, Motorola Corporation's $5 billion low-Earth-orbit debacle. Planned in the mid-1980s, the system was archaic by the time it was deployed in 1998, offering global communications from a brick-size, $3,000 phone at charges

from $6 to $30 a minute. "The Iridium business plan was locked in place 12 years before the system became operational," says Dan Colussy, the veteran aviation executive who masterminded Iridium's buyout and now reflects happily on it next to his pool in a particularly lush section of Palm Beach Gardens, Florida. "The idea was that a businessman would carry this thing around the world in his briefcase and dial home from Paris or London. Of course by the time it got up, nobody needed it in Paris or London." Colussy stepped out of retirement and into Iridium's destiny in 2000; he was a small investor in old Iridium, and thought it "a terrible waste to let this unique technological marvel just die."

Motorola, itself one of the big players in the cell phone revolution that made Iridium obsolete, should have known better. So should many of its partners, like Telecom Italia and France Telecom, each of which poured hundreds of millions into building 18 Iridium gateways, or ground-relay stations, around the globe. The project plowed on nonetheless and opened for business, eating up another $1 billion in operating costs during its first year.

By August 1999, Iridium was bankrupt. And by the fall of 2000—when Colussy was shuttling between the U.S. secretary of defense's office, Lloyd's of London, a member of the Saudi royal family, and Iridium's principal gateway, in Tempe, Arizona, to paste his deal together—Motorola was threatening daily to let the whole satellite network crash back to Earth. "All the software to bring it down had been uploaded," Colussy recalls. "I know because we later hired the guy who was in charge of it. He just had one button to push, and he was waiting for the call."

The call never came. Iridium flies still, six groups of eleven 1,412-pound satellites orbiting Earth every 100 minutes, guided from the basement of a featureless two-story office building in Leesburg, Virginia, which houses a bank of Sun computers as long as a football field. Two or three techies lounge in a room next door, making sure a wall full of monitors bleep the way they are supposed to.

Is maintaining the grand celestial miscalculation worth it? At an investment of $5 billion, of course not. But at $25 million, plus an undisclosed amount Colussy and his partners agreed to invest after the purchase, it may very well be.

Iridium and Globalstar, a satellite phone competitor that also went bankrupt, though with a somewhat smaller loss, were a triumph of engineering over common sense. "People have realized by now that the way to go into the satellite business is to start localized so your initial investment is low," says Max Engel, who follows space communications for the consulting firm Frost & Sullivan. "XM Radio, for instance, which I have in my car, uses just two satellites. Iridium's system was based on building [for] the whole globe, then wondering whether you were going to have any customers."

Iridium's architecture locked it into massive upfront costs. The project was the world's biggest deployment of low-Earth-orbit satellites (known in the trade as LEOs), which hover a mere 483 miles above our heads, compared to 22,000 miles for geostationary satellites (GEOs). A LEO network's proximity to Earth all but eliminates the half-second signal lag users of geostationary communications experience, an advantage Iridium counted on as a great selling point for its telephone service. But the lower altitude of LEOs shrinks the service footprint of each satellite. From 22,000 miles up, one

MOTOROLA WAS THREATENING DAILY TO LET THE WHOLE SATELLITE NETWORK CRASH BACK TO EARTH.

geostationary satellite can fan out communications to a third of the world; each Iridium LEO satellite, on the other hand, reaches just 1/66 of the globe, so any one or two are usually useless without the others in the constellation.

Motorola's engineers, hunkered blissfully away from the rest of the world for 12 years, did come up with some advances. Iridium's satellites are the only ones in the cosmos that communicate with one another as well as bounce signals back to Earth. That capability makes the system the only one in the world that can connect absolutely anywhere to absolutely anywhere else, should a North Pole explorer have an immediate need to reach a South Pole colleague. And Iridium is easy to use while in motion—at sea, in an airplane, or in a desert Humvee, for instance; finding the nearest of the 66 orbiting satellites requires only a small telephone antenna. Transmissions to distant geostationary satellites, on the other hand, require users to lug around much bigger antenna contraptions.

With dozens of satellites to launch, Iridium's constructors had to figure out how to build and launch them cheaply—and quickly. "They learned to make a complete satellite in two to three weeks, where a geostationary craft takes 24 to 36 months," says Mark Chartrand, a satellite industry consultant based in Baltimore. "They were so small and light they could send several of them up on one rocket. Technically, this is a good system." Indeed, at the peak of satellite construction, Iridium was turning out a satellite a week.

The launches began in May 1997, and within a year, 66 satellites had been launched, plus a few spares. There were also some failures: The old Iridium launched 16 satellites that never achieved the proper orbit or were inoperable after reaching orbit. As for launch vehicles, Iridium was true to its global roots, sending up Boeing Delta-2s from U.S. bases, Protons from Russia and Kazakhstan, and Long Marches from China. Protons were capable of lofting five Iridium satellites at a time, while the Long Marches could handle only two.

When Colussy was negotiating for Iridium, he learned that there were seven spare satellites in storage, which he arranged to have launched after the takeover. Including operational satellites, spares, and failures, Iridium has launched 95 satellites.

As successful as the Motorola de-

signers were in coming up with small, manageable satellites, they made a dire mistake: they chose a pitifully small (by 2004 standards) band for transmitting data. The $5 billion system can send no more than 2.4 kilobits per second. Globalstar, also built in the 1990s, offers 9.6 kilobits. A standard dial-up computer modem, the one you likely dumped for cable because it was maddeningly slow, does 56 kilobits per second. "Motorola designed this system in the mid-1980s for voice, and now almost all our customers want to link their palm top or laptop to it," admits Mark Adams. "A big part of my job has been to roll out data services working with what we've got. To say, 'Here's this multibillion-dollar infrastructure. What else can we do with it?' "

Adams' answer: Short-burst data from sources far beyond the reach of either dial-up or cable. Oil companies, for instance, can place Iridium-linked sensors along their Canadian or Siberian pipelines, sending one-line messages to headquarters in case of a leak or other emergency. Trucking and shipping companies can keep track of their fleets. "There are lots of vertical markets that can use transmission speeds below 10 kilobits," remarks D.K. Sachdev, a retired executive from the satellite consortium Intelsat. "Look at BlackBerry [a hand-held wireless device that enables users to receive and answer e-mail], which has been a great success among executives."

Before Adams could tweak his multibillion-dollar infrastructure, though, Colussy had to save it from being dumped in the Pacific. He came up with a business transaction nearly as global as Iridium itself. "The old Iridium board was a United Nations of investors who owned the gateways around the world," Colussy recounts. "Naturally I started with them" in seeking backers for the new Iridium.

Colussy, who tells his tale over fresh tuna and watermelon served at an umbrella'ed patio table by a uniformed servant, brought a background as corporate American as they come. An engineer trained at the U.S. Coast Guard Academy in the 1950s, he added a Harvard MBA, then rose to the position of president of Pan American Airways in the 1970s. He converted the last company he ran, UNC Corporation, from a struggling builder of nuclear powerplants for submarines to a thriving aviation services provider, then sold it in 1997 to General Electric for $725 million. By 2000, he was comfortably retired. Still, he couldn't resist the opportunity to turn Iridium around, so he started making calls to see who was willing to throw good money after bad.

In the end, he got four investors. The first was Syncom, a Washington, D.C.-based firm specializing in telecommunications investments that was eyeing Iridium for its potential in Africa and other developing regions. The second, Saudi Prince Khalid, he never met, but Colussy recalls that he "had some pretty tough negotiations with [Khalid's] investment bankers." The third investor was Brazilian telecom company Inepar. Colussy then added Quadrant, headed by an Australian venture capitalist.

Colussy was also working the Pentagon, with a lot of help from Mark Adams, who at the time was an engineer with the consulting firm Mitre Corporation. Although Motorola had originally rebuffed the Department of Defense (one more miscalculation), the armed forces eventually became part of the original Iridium consortium. They even built a secure system gateway in Hawaii for military use. Adams and Colussy got Department of Defense officials to commit to giving them $36 million a year in military

business if their buyout came off.

With this success, Colussy went to Chase and a battery of other banks that owned Iridium's assets in lieu of the money they had lent. In the spring of 2000, the creditors had almost gotten $600 million from Craig McCaw, America's first great cell phone entrepreneur. Then the dot.com bubble burst, stock markets dipped, McCaw retreated, and Colussy's motley crew, with its $25 million, was the only group left willing to back Iridium. "It wasn't a friendly environment," Colussy says in his unflappably modulated CEO voice. "But once they picked themselves up off the floor, they decided $25 million was better than nothing."

Last-minute talks with Motorola, which was keeping Iridium aloft while the money men decided its fate, centered on the Earthbound topic of insurance. Motorola, already stung by lawsuits from original Iridium investors, wanted assurance it wouldn't face any future liabilities from satellite debris plunging to Earth. "The chances of one of these hitting anyone's house are pretty small," says Colussy. Still, Motorola demanded full indemnity.

After meetings in London, Colussy produced a $3 billion policy from Lloyd's. Not enough, Motorola said. Colussy, with help from his lawyers, then recalled an obscure federal law allowing the Department of Defense to indemnify civilian contractors engaged in hazardous work. He had used it in his Pan Am days so the airline could fly to Saigon during the Vietnam War. One problem: Authorization had to come from the secretary of defense. During the late fall of 2000, with Motorola past its deadline for trashing Iridium, Colussy managed to get meetings with top Pentagon officials, including then-Secretary William Cohen. By December 12 Motorola had its indemnity, and Colussy and his investors had Iridium.

ONLY IRIDIUM CAN CONNECT ABSOLUTELY ANYWHERE TO ABSOLUTELY ANYWHERE ELSE.

Next came the task of converting the vast, gold-plated corporate Iridium into something as close to a garage start-up as Colussy and Adams could get it. Under Chapter 11 bankruptcy, the company was relieved of interest payments on about $5 billion in debt, which immediately lopped 40 percent off Iridium's costs. Step two was to cut out Motorola, which had been charging the consortium $45 million a month in operating fees. Colussy switched to Boeing, which did the job for $3.5 million per month. Colussy closed corporate offices in favor of the Leesburg facility, rehired only 200 of the 600 employees that had been let go, returned to operational status only one of the 18 gateways (the Pentagon's gateway in Hawaii had been excluded from closure), and ended up with eight percent of the old system's costs. The original Iridium had needed one million customers to break even; the new version required only 60,000.

Colussy is the first to admit that Iridium will never achieve anything like its originally intended glory. "If you have a cellular or hard-wired phone system where you are, that's always going to be the way to go," he says. "Iridium will never be as cheap."

Conceived in the age of voice and woefully underequipped in today's age of data, low-Earth-orbit satellites are now commonly acknowledged to have

been a wrong turn off humanity's highway to the colonization of space. "The guys at Iridium are doing a good job with what they have," says D.K. Sachdev. "But how many electronic systems that were designed in the 1980s are you still using?"

The rescue of Iridium does have implications for organizations wanting to manage technology reasonably. The satellite industry started in the 1960s not as an industry at all, but as an array of government consortia—Intelsat, Inmarsat, Eutelsat, among others—viewed as a second front in the space race and cold war, with all the costs-be-damned culture that entailed. By the 1980s, most LEO projects were captained by big military contractors such as Motorola and Lockheed.

Colussy's Iridium restructuring started a completely different trend. Since December 2000, little-known private investors have taken over one satellite company after another, betting their own cash on squeezing and niche-positioning them back to health. Last year, Inmarsat, a one-time state consortium focused on maritime communications, was bought by two British venture capital firms. (Inmarsat, a geostationary system that can carry data at broadband speeds, has been running the Iraqi Central Bank's information systems.) Globalstar emerged from its own bankruptcy this spring, purchased for $43 million by New Orleans-based investment company Thermo Capital. Intelsat, the industry godfather, was privatized in 2001 to its original consortium of governments and former state companies, with a promise to make its shares available on the stock market this year.

Technical director Mark Adams thinks small on a daily basis, particularly when laboring over a new-generation phone that will be less than half the original Iridium's size, and, at under $1,500, less than half the price. Adams' watchword is conservation. He and his team have extended the projected life of Iridium's satellites from 2005 to 2014 through various resourceful measures. The least reliable system on an Iridium satellite, for instance, is a gyroscope that keeps the craft facing the sun, from which it draws energy to power its batteries. Adams and co-workers have figured out how to use thrusters to orient the satellites, saving wear and tear on the fragile gyroscopes. Now Adams and his team are working on extending battery life by letting the satellites take turns hibernating at certain points in their orbits. "These systems, like many products of American engineering, were fundamentally overdesigned," says Adams. "They were meant to fly five to seven years, but have enough battery for 20. That gives us a lot of ways to stretch that lifespan."

As for Colussy, now 73, he ran new Iridium for about a year, then passed the reins to chief executive Gino Picasso, who has searched far and wide for a few more customers. Iridium use is picking up among ranchers in the Australian outback, Colussy is pleased to report. And the company is challenging Inmarsat among commercial fishing fleets. New Iridium has run pilot projects in the villages of Senegal, giving native sons who are working in Paris or Washington, D.C., their first chance to phone home.

While his successor nurtures these seeds of growth, Colussy is thinking about the next phase for the satellite industry as a whole. What he sees, now that he has helped break it down into manageable bits, is an imperative to make it bigger and stronger again through mergers. "What needs doing in the satellite business now is consolidation," Colussy says, the gleam in his eye suggesting he's mulling prospects more exciting than the afternoon golf game he's scheduled.

Restore

Northwest Passage | Lockheed Electra

"I saw airplanes like this one coming and going many times in my high school years," says Bill Taylor, nodding at the Lockheed Electra in a hangar at the New England Air Museum, outside Hartford, Connecticut. Taylor's boyhood home in St. Paul, Minnesota, was located on a cliff overlooking the Mississippi River and Holman Airport. Northwest Airlines sent its Electras in and out of the latter several times a day, flying passengers and freight to and from Chicago.

In 1934 this particular Electra, a 10A, serial no. 1052, rolled off the Lockheed assembly line in Burbank, California, just three serial numbers before the 10E, a model with more powerful engines, in which Amelia Earhart would disappear in the Pacific in 1937. The U.S. Navy was 1052's first owner. Dressed in navy blue and bearing the Navy designations XR20-1 and BuNo 0267, the Electra was the personal transport of Secretary of the Navy Claude Swanson. During World War II, it transported Assistant Secretary of Naval Air David Ingalls. Post-war, the airplane went through nine owners, working for a drilling company and carrying freight and passengers. In 1979, North Carolina resident Dolph Overton bought it from Skyway Aviation in Missouri and set about restoring it for his Wings and Wheels Museum.

In 1983, along came Grace McGuire, who dreamed of reenacting Earhart's flight. Searching for a 10E, she found a basket case at a Christie's auction. United Technologies (parent company of Pratt & Whitney, which had made the Electra's engines) heard of her plan and offered to restore the 10E to flying condition. Once the aircraft was evaluated, however, it was plain that the project would bust its budget. Plan B: Find one of the more plentiful 10As, replace the R-985 Wasp Jr. engines with the more powerful R-1340 Wasps that the 10E wore, and use McGuire's 10E for parts. In 1984, United Technologies bought Dolph Overton's 10A and got to work. Then McGuire fell ill with Lyme disease, and United Technologies changed management and ditched the McGuire project. The company returned McGuire's 10E to her (last spring, it was up for sale) and gave the 10A to the New England Air Museum.

HAROLD DAVIS

An Army National Guard Chinook dropped off the biggest chunk of the Museum's Electra in 1994.

There was no space for it at the time, so the museum put it up in a Pratt & Whitney employee's storage space in Lisbon, Connecticut, with the proviso that if it remained there longer than 10 years he could have it. In 1994, two days before the deadline, the museum hauled the fuselage out in the sling of an Army National Guard helicopter and flew it to its brand-new hangar.

The 84-year-old Taylor, a 20-year museum volunteer, has been working on the restoration ever since. He and a team tore it down and cleaned it, bolt-

BARBE LA PIERRE (2)

The Museum opted to finish the Electra in Northwest livery (above), though it had come off the production line in military colors. The cabin interior (left) and the instrument panel (right) are nearing completion, but project manager Bill Taylor has no guides for the details.

ed on the wings and the tail assembly, repaired damaged cowls and nacelles, rebuilt the engines, reassembled the instrument panel and landing gear, fabricated missing wooden parts, and stripped, polished, and painted everything. Now, with just the interior left to complete, Taylor is the only one working on the airplane.

Taylor has refurbished the exterior in the livery of Northwest Airlines. "When we got it, the question was: Do we restore it to the way it came off the line?" says Taylor. "But the feeling was we had enough military airplanes."

The museum's Electra is not ergonomically friendly: You have to bend over at a 90-degree angle just to enter the rear cabin doorway. Taylor has 10 red leatherette seats positioned on both sides of the cabin and an aisle barely wide enough to walk in. In the original Electra the seats were probably cloth-covered, Taylor says, but he has no clue as to the colors or pattern. (He asks that anyone who might recall Northwest Electra interiors call him at (860) 623-3305 or e-mail him at *staff@neam.org*.) There is a lavatory, he points out, behind a bulkhead door in the aft cabin, in a crawl space four feet square, with essentially a chamber pot tucked into one corner. "You had to think twice before you wanted to go to that bathroom," he says.

Mysteries abound. There's a vintage Electra radio microphone wrapped around a yoke, but no place to plug it in. "We're trying to find where the radio equipment was installed, but none of the Electra pilots could recall it," Taylor says. "I think it went under the copilot's seat, but Grace said 'No way.' We have no instruction books that tell you how to put it back together. The external parts aren't so bad—it's obvious where the wings go." Everything else requires detective work.

—Phil Scott

CAROLINE SHEEN (2)

RUSS MAGNUSON

Taylor (above) used to watch Northwest Electras fly out of St. Paul, Minnesota. The Electra's tailwheel did not retract (right). The Junior Model 12 (top), 1937 vintage, was a scaled-down Model 10.

THE WOW FACTOR

WHY WARBIRDS THE WORLD OVER FLOCK TO WANAKA.

by Derek Grzelewski

Friday, April 9, Wanaka, New Zealand. The little South Island town seemed charged, as if a thunderstorm were imminent. It was barely 7 a.m., but the traffic was already thickening and the hotel's restaurant brimmed with customers, some wearing aviation ball caps, harrying the waitresses for their checks: "We gotta go! Can you please hurry up?"

CRAIG JUSTO/AERO ASPECTS

Several miles away, in the display area at the Wanaka airfield, stood the cause of all the hubbub: an assembly of some of the world's most prized warbirds. A World War I Sopwith Camel. A World War II Supermarine Spitfire. A cold war Lavochkin La-9. British Vampires, Russian Polikarpovs, Chinese Nanchangs, American Kittyhawks…

Today was the opening day of the Warbirds Over Wanaka airshow. The show originated with the aviation obsessions of Tim Wallis, a pilot who had made a fortune from a helicopter-based deer hunting operation he started in New Zealand in the 1970s. The money enabled Wallis to fulfill a long-held dream: In 1984, he bought a North American P-51D Mustang. Thus began what would evolve into the Alpine Fighter Collection, a group of vintage warbirds from around the world, almost all of which Wallis has had restored to flying condition.

The Lavochkin La-9, the Soviets' premier piston engine fighter, couldn't beat its jet-powered Korean War foes, but 50 years later, it commands respect at New Zealand's biennial warbird extravaganza.

In 1988 Wallis organized a one-day Warbirds on Parade show in Wanaka, his hometown. He showed off his four aircraft, as well as vintage gems from other col-

JOHN M. DIBBS/THE PLANE PICTURE COMPANY

Wanaka's show stands out for the wide range of nations and eras its aircraft represent. Above: The Brits' Bristol F2B, a fighter, also flew photo recon and ground attack missions in World War I. Right: a low-and-slow-flying Cresco cropduster, produced in New Zealand in the 1970s.

GLENN ALDERTON

lectors. The show was a success, attracting some 14,000 visitors and inspiring Wallis to hold warbird shows every other year at Wanaka ever since.

This year's show offered about 80 warbirds, including 12 presently in Wallis' collection. On the opening day, some 20,000 visitors roamed the airfield and took in ground displays and practice flights. The show proper began the next day. Against a vista of snow-dusted mountains, and with music from *The Terminator* blaring, the show's celebrity guest, Apollo 11 astronaut Buzz Aldrin, opened the program: "Gentlemen! Start your engines."

First up, roaring low and close to the

© PHILIP MAKANA/GHOSTS

grandstand: a pair of World War II warriors, a Curtiss P-40 Kittyhawk fighter-bomber and a Vought F4U-1 Corsair fighter. "It has always been a big dream of mine to bring a Corsair and a Kittyhawk to the show," Wallis explains, "because they are such a big part of the New Zealand air force heritage and the war in the Pacific." Royal New Zealand Air Force pilots also flew Douglas SBD Dauntless dive bombers and Grumman TBF Avenger torpedo bombers in the Pacific theater, and conducted maritime reconnaissance missions in Lockheed Hudson bombers and Consolidated and Boeing Catalina flying boats.

Wallis is keen to get the word out about New Zealand's long history of military air service, which dates back to 1913. (This is a sensitive issue: In 2001 Prime Minister Helen Clark cut the RNZAF's air combat capability, grounding the service's 17 McDonnell Douglas A-4K Skyhawk fighters and 17 Aermacchi MB-339CB jet trainers.) At this year's show, the RNZAF represented itself with a P-3K Orion reconnaissance aircraft, a C-130 Hercules transport, and a UH-1 Iroquois helicopter.

The Wanaka show also paid homage to the earliest days of New Zealand aviation, exhibiting a replica of an aircraft composed of bamboo tubing, fabric-covered wings, pram wheels, and a propeller whose two blades looked like oven trays. The aircraft portrayed had been designed and constructed at the turn of the century by New Zealander Richard Pearse. It embodied many remarkably farsighted concepts: a monoplane design, propeller blades whose pitch could be varied (at least on the ground), wing flaps, an aft-mounted elevator, and a tricycle undercarriage with steerable nosewheel. Pearse had even designed and built his own internal combustion engine. The exhibit informed showgoers that Pearse had first flown the craft on March 31, 1903, in Waitohi on the South Island; he went about 50 yards. Unlike the Wright brothers, though, Pearse did not have his flight photographed. He later opined that the flight had not been sustained and controlled, as the Wrights' first flights were eight months later.

The show also offered an example of modern New Zealand aviation: a formation of Crescos—cropdusters produced in New Zealand by Pacific Aerospace Corporation in the late 1970s. This particular group was owned by the New Zealand flying company Wanganui Aero Work.

XAVIER MÉAL

As a child, show mastermind Tim Wallis loved visiting a nearby base to watch P-51 Mustangs. At this year's show, a P-51 (below, at bottom) was paired with an unusual partner: a 1960s Czech Albatros jet trainer.

What sets Wanaka apart, though, are more exotic spectacles, such as a simultaneous takeoff of five Russian Yakovlev Yak-52s and five 1960s Nanchang CJ-6s—Chinese-built versions of the Yak-18 trainer.

There was no missing Wallis' interest in Russian aircraft. He's made sev-

GLENN ALDERTON

eral scouting trips to Russia. On one, in Siberia, he found enough parts of Polikarpov fighters to commission the restoration of three I-53 Chaikas and six I-16 Ishaks to flying condition. The I-16, conceived by Nikolai Polikarpov in the 1930s, is a low-wing monoplane with retractable undercarriage—the first fighter with that soon-to-be-ubiquitous design. The show featured a formation flight of two I-16s and one I-153.

Another Eastern-bloc attraction was the pairing of a Russian Sukhoi Su-31 and a Lithuanian aerobatic pilot, Jurgis Kairys. An engineer and test pilot for the Sukhoi Design Bureau, Kairys pioneered unlimited free-style aerobatic flying. Unlike traditional classes of aerobatic competition, which dictate the directions, axes, and other parameters in which a routine must be flown, the unlimited free-style class has few such rules.

Kairys' act began with a roar and a burst of smoke; suddenly he was airborne, more like a cannonball than an aircraft. Kairys yanked the Su-31 into a vertical climb, then leveled off, then climbed and leveled, again and again.

Next, Kairys climbed until his aircraft was almost out of sight. He plummeted down into a dizzying corkscrew dive, disappearing into a river valley below the airfield, emerging in full vertical climb and rolling the aircraft all the way up. At the climb's apex he paused, hanging the Su-31 from its propeller, before finally dropping down to repeat the routine. A lifelong pilot and World War II veteran watching the act shook his head and said: "Jeez! I'm glad I never had to dogfight this fella."

CRAIG JUSTO/AERO ASPECTS

MIKE JORGENSEN/ACTION AIR IMAGES

Two tough Russkies: The Polikarpov I-16 (above) wasn't a great World War II fighter, but once out of ammunition, some pilots just rammed it into enemy aircraft. Sukhoi's aerobatic Su-31 (left) has the highest power-to-weight ratio of any piston engine aircraft ever built.

The afternoon brought another rarity, the world's only airworthy Lavochkin La-9. Compared with the chubby Policarpovs, the La-9 looked sleek, fast, and powerful. Seeing the two side by side, you could only marvel at how rapidly the design of Russian piston engine aircraft had advanced in just 20 years.

World War II was over by the time the La-9s became operational. They served the Soviet Union and other Eastern bloc countries. North Korean pilots flew them in the Korean War, but they could not compete with the North American F-86s and other jet fighters fielded against them, so many were converted for ground attack, a role they performed more successfully.

Only five La-9s exist today. This specimen had been taken out of service with the Chinese air force in the early 1960s. After 10 years of negotiations, it is now owned by Ray Hanna of the Old Flying Machine Company in Great Britain and Garth Hogan of Pioneer

Aero Restorations in Auckland, New Zealand. The owners had the engine and propeller overhauled in the Czech Republic in 2002, while the airframe was shipped to Pioneer Aero Restorations. Luckily, Hogan's team had most of the parts it needed. "Our main obstacle was that, although we scoured the world to learn as much as we could about the La-9, our best source of documentation was an operation manual written in heavily jargoned Russian," Hogan recalls. "Often the translations we had done made no sense at all."

The restoration took two years. Finally, in March 2003, the La-9 flew again, piloted by New Zealand airshow coordinator John Lamont.

It was also Lamont who flew it today, roaring past the grandstand at jet speed. Suddenly he looped away and disappeared from the sky. A silence fell as the crowd tensely scanned the horizon. Finally, the show commentator announced that the La-9 had developed engine trouble and the pilot might need to land at another airfield. In the end, he did land in Wanaka, away from the crowd, and taxied to the hangar. The engine problem was fixed, and the La-9 was pleasing crowds the next day.

On Sunday came yet another Eastern Bloc show-stealer, the graceful Czech-built Aero Vodochody L-39 Albatros jet trainer. The 1960s design flew wingtip to wingtip with three unexpected partners: two de Havilland Vampires—fighters designed in the 1940s—and a Cessna A-37 Dragonfly light strike-fighter, which served in Vietnam.

The show finally erupted into a crescendo finale: nine of the show's star aircraft simulating an air battle and an attack on the airfield. The gladiators then dispersed, and we were brought down to earth and the reality of a mega-traffic jam caused by 29,000 people all trying to get home.

In 1996, Tim Wallis crashed a World War II Supermarine Spitfire; now another Spitfire and pilot fly at the show (above). Right: A WWII reenactment group called the Warhorses shows off its vintage vehicles, uniforms, and other gear at Wanaka.

XAVIER MÉAL (2)

SIGHTINGS

When Tyson Rininger overheard an exchange between a grandfather and grandson at a California airshow several years ago, he understood one of the goals of the U.S. Navy's Legacy flights, which pair vintage aircraft with the Navy's newest jets. Pointing to the World War II F4U Corsair flying in formation with an F/A-18, the grandson asked what kind of airplane it was. The older man answered, then asked his grandson the name of the modern jet alongside it.

Rininger has photographed dozens of Legacy flights, but it was a rare treat last March to attend a Legacy training session at California's Lemoore Naval Air Station, where 10 pilots went through three days of ground school and flight training to become certified for this unique class of formation flying.

Working in the close confines of an L-39 jet trainer, Rininger had to turn his head and look out the corner of his eye through the viewfinder, then "fire away and hope I got something" to capture an F/A-18 flying with a FJ4B Fury (below) and F8F-2 Bearcat (opposite, bottom).

Oddly, it was a scene back on the ground that drew the most attention from pilots and photographer alike: a collection of old warbirds lined up next to a T-28 (opposite, top).

NATIONAL ARCHIVES

A Mitsubishi Ki-21 Sally bomber is hit by fire from a U.S. Navy Liberator.

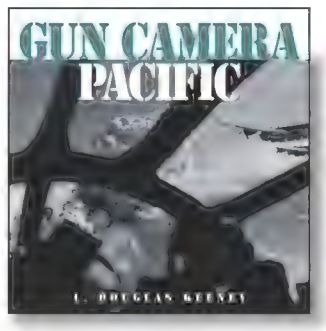
Gunsights

Gun Camera Pacific

by L. Douglas Keeney. MBI Publishing Company, 2004. 132 pp., $24.95.

It is said that World War II was the black-and-white war. Unlike the first world war, it was widely photographed, but predominantly with black-and-white film, rather than rarely available color film. Some publications trumpet their use of untouched World War II color, while many of the military's best black-and-white images are rarely seen.

For 14 years, the official U.S. Army Air Forces' images of the war—those taken by soldiers or military photographers—were held at the National Air and Space Museum. I was privileged to be one of the staff charged with the care and use of that collection, so I know it well. In 1998, the collection was moved to the National Archives and Records Administration facility in College Park, Maryland, where it is now housed with the official images of the Army and Navy.



From that combined collection, L. Douglas Keeney has picked what he feels best shows the air war in the Pacific. The title is only slightly misleading—not all of the over 175 black-and-white images were taken from the cameras synchronized with the guns on aircraft, and not all were taken during combat. Some, like a photo of nervous gunners, were taken before an attack. Others, like a photo of a pilot staring incredulously at the near-severed tail of his P-38 Lightning, are taken post-battle.

Gun Camera Pacific is not a history of the naval air war—the earliest photos featured in the book were taken in 1942. And given the proportions of forces in the Pacific, one would expect more Navy aircraft to be featured, but images of Army Air Forces aircraft—including B-29s, B-25s, and P-51s—outnumber those of prominent Navy aircraft, like the F4U Corsair and F4F Wildcat.

The images captured during battle are often stunning, such as a sequence depicting a trio of Douglas A-20 Havoc bombers attacking a Japanese-held lagoon in New Guinea. One Havoc, disabled by flak, tumbles into the sea and disintegrates while the camera plane and another A-20 continue home. On these pages, ships explode, bombers lose wings, and fighters plummet into the sea.

Readers may be so moved by some of *Gun Camera Pacific*'s glossy, high-quality images that they will want to obtain copies. Unfortunately, just a scant few show the negative number etched in a corner. Incorporating the numbers into the captions or adding an index of them would have been most helpful.

—Brian Nicklas is a member of the National Air and Space Museum Archives staff and an Air & Space/ Smithsonian *contributing editor.*

Air Power: The Men, Machines, and Ideas That Revolutionized War, From Kitty Hawk to Gulf War II

by Stephen Budiansky. Viking Penguin, 2004. 441 pp., $29.95.

Stephen Budiansky is a former national security correspondent at *U.S. News & World Report* and the author of *Battle of Wits*, a book on World War II code-breaking. In *Air Power*, he sets out to establish the airplane's relationship to 20th and 21st century war and strategy.

Beginning with a look at the careers of Ohio's two most famous bicycle mechanics, Budiansky walks the reader through aviation's early days, World War I, the somnolent 1920s and 1930s, World War II, Korea, Vietnam, Operation Desert Storm, and the recent conflicts in Afghanistan and Iraq. Along the way, he examines and places in perspective every major theory of air power, including nuclear deterrence and tactical ground support.

The U.S. air arm's stubborn adherence to the doctrine of strategic bombing and

its belief that air power can reduce ground forces to mere moppers-up is familiar lore. But Budiansky relentlessly lays out the evidence to the contrary, reminding us that the strategic bombing of Nazi Germany did not panic the populace and forced only a few German factories to add second shifts.

Budiansky stops short of suggesting that any World War II air corps leaders be posthumously taken out and shot for idiocy. But his presentation of statistics and analysis makes the reader share his enthusiasm for driving a spike through the doctrine of strategic bombing.

A sprinkling of black humor enlivens the book, among which is General Curtis LeMay's famous threat to have his Strategic Air Command bomb North Vietnam "back into the Stone Age." Complete destruction of North Vietnam's industrial capacity, a fundamental of strategic bombing theory, would have cut the tiny nation's gross domestic product by only 12 percent or less.

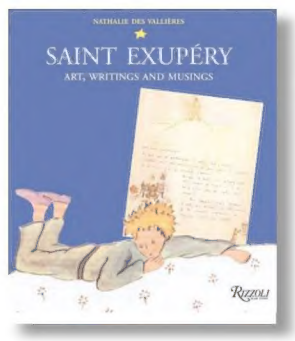
As fighter pilots began to replace the U.S. Air Force's bomber generals after Vietnam, and as technology finally began to deliver the miracles predicted for nearly a century, the Air Force began a transformation that continues today. Its new capabilities—such as the Predator drone armed with Hellfire missiles—can, on a limited basis, do what many 20th century generals had believed possible since 1914: eliminate enemy ground forces before the Army even sees them.

In sum, *Air Power* is a fascinating, well-researched work that beginning historians can understand and seasoned historians will find both informative and entertaining.

—William Jeanes was a ship's company officer aboard the aircraft carrier USS Intrepid *and a former editor-in-chief of* Car and Driver.

Saint Exupéry: Art, Writing and Musings

by Nathalie des Vallières. Rizzoli International Publications, 2004. 215 pp., $50.



French officials announced earlier this year that a 60-year-old mystery—what ever happened to Antoine de Saint-Exupéry?—had been solved: The wreckage of an F-5B, a modified P-38, found off the coast of Provence, France, was identified as his. The announcement was timed perfectly for the release of Nathalie des Vallières' coffee table book about her great-uncle.

If flight ever had a secular literary saint, Saint-Ex, as he was known, would be the man. All his books—*Southern Mail*; *Night Flight*; *Wind, Sand and Stars*; *Flight to Arras*; and his classic final work, *The Little Prince*—centered on flying. His prose reads like poetry, and he was also a gifted artist—all the illustrations in *The Little Prince* are his.

Des Vallières paints a remarkable portrait of her great-uncle. The book is packed with his playful drawings, letters, manuscripts, and mechanical drawings in his often-illegible hand (and he could never hold a left margin), most of it on hotel stationery and paper napkins. Sprinkled throughout are photos of Saint-Ex, many taken beside the wreckage of some early French airplane in the desert. (He crashed more than an obsolete PC.)

The book is repetitive, but that doesn't ruin the total effect. We learn that he was dedicated to the women he loved, to the dwindling number of his pilot friends (who tended to die flying), and most of all to his beloved France. Saint-Ex's final letters indicate premonitions of his death flying reconnaissance. It's a fitting ending to a moving book.

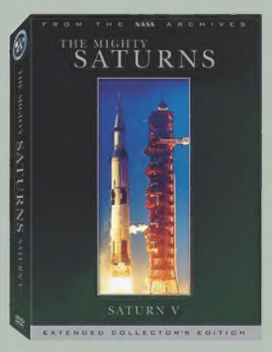
—Phil Scott is a frequent contributor and author of the upcoming Deadly.

NEW ON DVD

The Mighty Saturns: Saturn V

Fox Home Entertainment, 2004. Three-DVD set, $49.98.

When I was a kid, I used to draw Saturn Vs all the time. You could recognize them easily: the black-white banding between stages, the vertical "U.S.A." artfully painted in red down the sides, the needle-thin escape rocket on top.



While it is amusing to page through those old pictures today, watching the new DVD set *The Mighty Saturns: Saturn V* is a whole lot better. Three years ago, veteran broadcast pro Mark Gray set out to remaster original NASA footage to make the images of his childhood available to the public. Since then, he's released DVDs on most of the Apollo missions, the Gemini program, and a Hubble servicing mission. Now, the Saturn V gets its moment in the spotlight.

That's nine hours of spotlight. Gray has loaded this three-disc set with an enormous amount of material. The 43-minute original documentary in Disc One is really just the appetizer; the main course is the archival footage of every aspect of the Saturn V program.

You see, and hear, it all. Static film shots, tracking shots, live TV feed, all from an amazing diversity of perspectives. Launch junkies, here's your fix. The bone-shaking experience of a Saturn V launch is reproduced again and again and again in sharp digital picture and sound, so you have no trouble feeling the rocket's 7.5 million pounds of thrust crackling through the Florida air.

Quarterly film reports from NASA on the Saturn V program and additional launch footage make up the third disc. These reports, produced by the Marshall Space Flight Center, are gems of Disney-esque 1960s documentary, expounding progress of the program in grandfatherly tones.

The Saturn V produced 160 million horsepower when it left the pad, double what all the rivers and streams of America would churn out if run through a single massive hydroelectric plant. Each stack was as tall as a 36-story building, and weighed more than a navy destroyer. It was designed and built by a team of hundreds of thousands—and it got us all the way to the moon. If ever there was a heroic machine, this was it, and these DVDs do it justice.

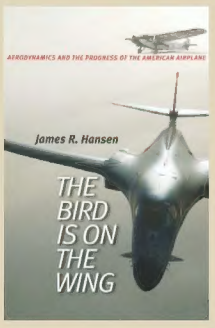
—George Whitesides is the executive director of the National Space Society.

BRIEFLY NOTED

The Bird Is on the Wing

by James R. Hansen. Texas A&M University Press, 2004. 272 pp., $24.95.

Before reading *The Bird is on the Wing*, you would do well to roll your coziest reading chair up to a computer and ready an Internet search engine. This history of big-picture aerodynamics drops the names of obscure aircraft (the Armstrong Whitworth AW-52), concepts (the SCAT-16), and devices (spiroid wingtips) you'll be itching to get a look at, but suffers a deficiency of illustrations. Author James R. Hansen, an *Air & Space/Smithonian* contributing editor, confesses early on that *The Bird Is on the Wing* is a "streamlined account" of material in his heftier reference works, which were "unlikely to attract many cover-to-cover readers." His text is formal, but it moves quickly through design improvements (engine cowlings) and developments (the delta wing) while only glancingly citing mathematics and items of human interest. Ultimately, the book fosters an appreciation of engineering realities in various eras of aircraft design.



—Sam Goldberg

CREDITS

Basic Instinct. O.H. Billmann recalls that taking off in a B-45A bomber in the summer heat of Yuma, Arizona, was like trying to get airborne in a United Van Lines moving truck.

Unfriendly Persuasion. Philadelphia science and technology writer Mark Wolverton grew up during the cold war and still worries about atomic bombs.

Beached Starship. Writer and pilot Mark Huber first admired a Beech Starship in 1993. Short the $5 million purchase price, he resolved to some day write an article about the airplane, using that as a crafty excuse to fly one. "I waited too long to pull this scam with the Concorde," says Huber. "I wasn't going to make the same mistake with the Starship."

The Mystery of the Lost Clipper. Gregg Herken was chairman of the space history department at the National Air and Space Museum from 1988 to 1996. Last year, he left the Museum to join the founding faculty of the new University of California campus in Merced, California.

Ken Fortenberry is an award-winning journalist who currently publishes a community newspaper in Denver, North Carolina.

50 Years of Hercules. Longtime contributor Carl Posey resides in Alexandria, Virginia.

"Super" Hercules. Illustrator Harry Whitver is a frequent contributor and avid aviation fan.

Helluva Catch. James R. Chiles wrote *Inviting Disaster: Lessons From the Edge of Technology* (Harper, 2001).

Tiny Turbines. Ed Regis' most recent book is *Biology of Doom: The History of America's Secret Germ Warfare Project* (Henry Holt, 1999).

Newspaper photojournalist Erik Lunsford is working on getting a private pilot's license.

Special Report: Turn Off That Phone! John Croft is an aerospace engineer and certified flight instructor. He spent nearly two decades designing and building satellites at NASA.

The Rise and Fall and Rise of Iridium. Craig Mellow is a New York-based freelance writer who specializes in international business.

David Povilaitis is a multi-media artist living in Sonoma County, California.

Northwest Passage: Lockheed Electra. Phil Scott's latest book, *Deadly*, will be published in October.

The WoW Factor. Writer and pilot Derek Grzelewski lives in Wanaka.

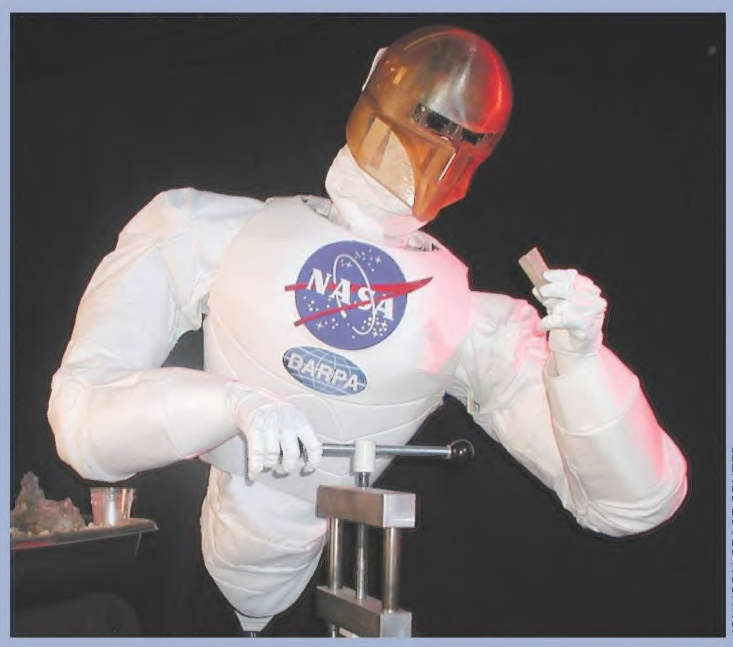
FORECAST

In the Wings...

The Hubble Repairman
Three candidates applied for the position NASA advertised to fix the Hubble Space Telescope. One had a grapple fixture for a head. One had three arms. None will need a pressurized spacesuit.

Seeing in the Dark
Developed from the old "starlight scope," an image intensifier used by U.S. forces in Vietnam, night-vision goggles first made it into military aircraft in the 1970s. Dozens of fatal accidents later, the military is finally seeing light at the end of this technological tunnel.

How to Find Your Way on a Runway
A handy guide to the lights, symbols, numbers, and signs that lead a pilot from touchdown to gate.



JOHNSON SPACE CENTER

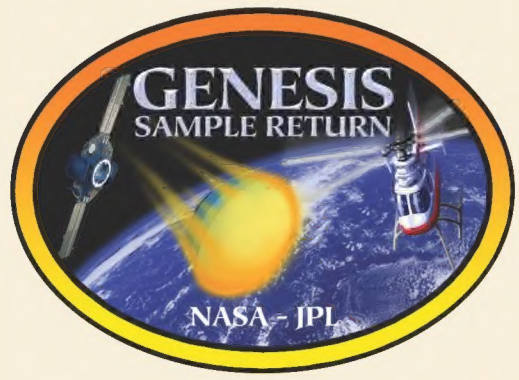
Robonaut is one of three applicants NASA considered for the job of spacecraft maintainer.

Studying the Classics
Scrupulously researched, the restored warbirds in the new Flying Heritage Collection are authentic down to their cotton-coated wiring.

The Airplanes of Howard Hughes—BONUS POSTER
In *The Aviator*, an upcoming feature film about the flight-struck Hughes, dozens of airplanes appear on the screen. Here's the real story behind the ones Hughes flew or funded.

ON THE WEB SITE

www.airspacemag.com



The Genesis mission will return samples of the solar wind to Earth this September (see "Helluva Catch," p. 46). In preparation for the mission's grand finale, helicopter pilots have been training to fly in formation with the returning space capsule and snag it in midair. One such capture, caught on video, is now on the Web site. Other videos include launches and reentries during the Gemini program, flights of the vertical-takeoff-and-landing "tail sitters," a pilot ejecting from a Sukhoi Su-29 aerobatic aircraft, and wind tunnel tests showing the motions of wings and other airplane components after a synchronized vibration, or flutter, has been induced.

Good Gyrations

ART GREENFIELD/NAA

Andy Keech and Woodstock *dropped in at the Wright brothers' memorial in Kill Devil Hills, North Carolina, in 2003.*

Six years ago, Andy Keech decided to build an autogyro that would be safe, dependable, and able to fly long distances. Recently, Keech proved his autogyro to be one of the best-performing aircraft of its type. Having already set several world aviation records in his yellow Little Wing LW-5 autogyro, nicknamed *Woodstock* after the bird in the comic strip "Peanuts," last February he flew 617 miles without landing, besting a Brit's 2003 record by 32 miles.

The biggest challenges in setting the record came in building the aircraft. "I consider myself an ordinary pilot, but *Woodstock* is an extraordinary aircraft," says Keech, a 64-year-old native of Australia who now lives in Washington, D.C. "I could not have set that record in a different autogyro."

The autogyro, a product of the 1920s, is rarely seen today. It uses rotary-wing technology—helicopter-like blades—to generate lift. However, the rotor is not powered by an engine. Instead, an engine powers a propeller that moves the aircraft forward. Forward motion causes the rotor to spin, creating the lift usually produced by an aircraft's wings.

Of the few autogyros built today, most are "pushers," with propellers mounted on the rear of the aircraft. *Woodstock* has a tractor, or puller configuration, with a 115-horsepower Rotax 914 engine and a propeller on the front.

"The best types of autogyros were pretty much forgotten. They were grand machines that made transcontinental flights and flew to Central and South America. I decided that's the kind of aircraft I wanted."

The puller design fell out of favor when the less expensive pushers came along. "The best types of autogyros were pretty much forgotten," Keech says. "They were grand machines that flew everywhere. They made transcontinental flights; they could fly down to Central and South America. I decided that's the kind of aircraft I wanted."

Keech became enamored with pullers after meeting autogyro designer and builder Ron Herron. When Keech saw Herron's trailer hauling a Little Wing autogyro, "I was quite taken with it. It was like nothing I had seen before," he says. "So I started talking to him, and we began collaborating." The two worked together in Arkansas to design and build *Woodstock* over the next five years, logging some 1,000 hours to complete it.

Herron favors the tractor configuration because undisturbed airflow into the propeller disc provides better engine cooling, increases propeller efficiency, and generates less noise. (Airflow to a rear-mounted engine is "disturbed" in traversing the length of the fuselage.) And, he says, "Little Wing autogyros have the look of the original Cierva, Pitcairn, and Kellett autogyros of yesteryear."

Keech first tested *Woodstock*'s long-distance legs in October 2003, making transcontinental flights across the United States in both directions. *Woodstock*'s original fuel capacity was 12 gallons. For the transcontinental flights, Keech and Herron installed a 24-gallon tank in the cabin. For the distance record attempt, an additional 14-gallon tank was installed on the belly, bringing total capacity to 50 gallons.

A winter flight at more than 10,000 feet usually means sub-freezing temperatures, and *Woodstock* had no cabin heat. Keech bought clothing designed for Arctic conditions and made sure the cabin was well sealed, but still feared hypothermia.

On February 22, Keech took off near Little Rock, Arkansas, heading east in favorable winds. Cabin temperatures at around 12,000 feet stayed well above freezing. He landed in Hickory, North Carolina, five hours and 38 minutes later, having eclipsed the record with two hours' worth of fuel remaining—enough for another 200 miles. "But a bird in the hand is good enough," he says.

"It's been one of my life's real pleasures, building *Woodstock* and flying it," Keech adds. "It's a relief that it's done, but it was exciting to go through the experience."

—Dustin Gouker

Moments & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at www.naa-usa.org *or call (703) 527-0226.*